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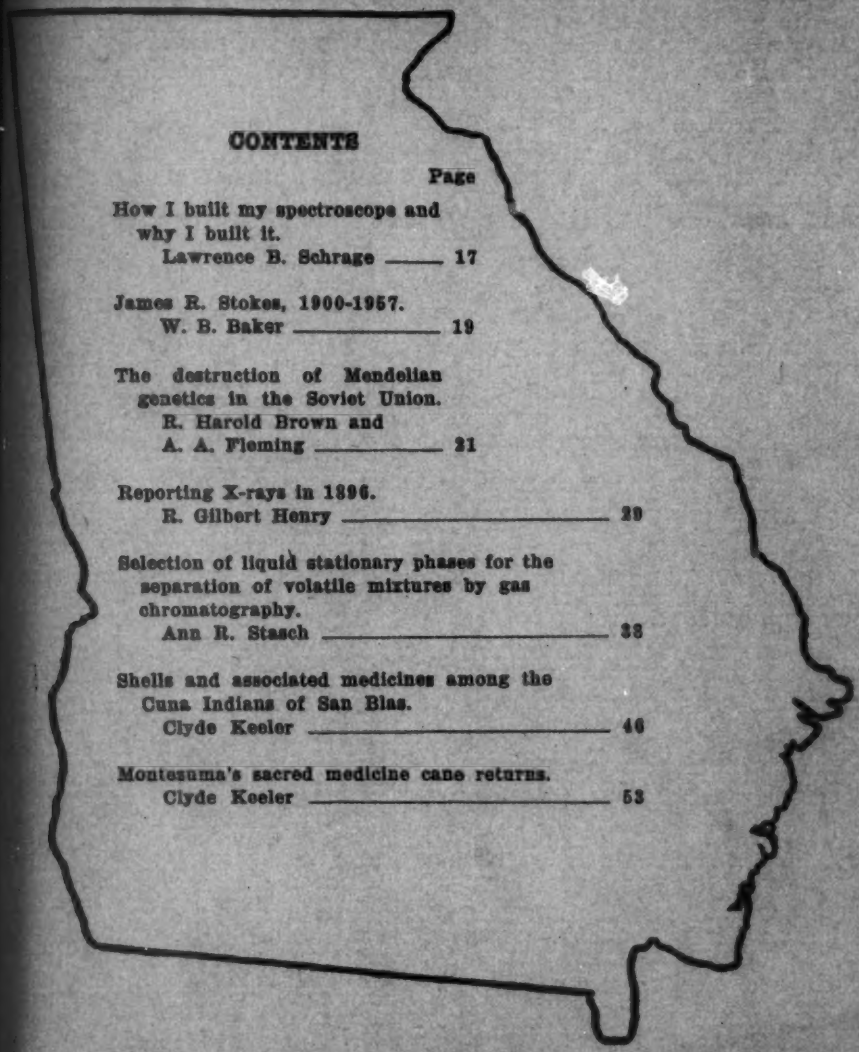

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HOW I BUILT MY SPECTROSCOPE AND WHY I BUILT IT[1]

LAWRENCE BRYANT SCHRAGE
Gainesville Junior High School

I became interested in Spectroscopes when I visited the FBI Building in Washington, D. C. They were using the Spectroscope for crime detection. A little piece of paint, and they had their man. But I was too little, and did not understand how it worked. After a few years in school we studied about Spectroscopes, and how it worked, and I became interested in building one. When I first learned I thought that it was very simple. But later on, when I started to put one together I learned better.

The first trouble I had was to get a lens for the Collimator. I finally found an old telescope which an aunt of mine gave me when I was six years old, and I took it out of the mounting. Then I looked around for something to mount it on. In grandma's basement I found an old broomholder, that was a piece of 2 x 4 mounted on a heavy piece of plywood, and that was just fine. But the slit gave me lots of trouble. At the end I took some razor blades mounted them between pieces of Masonite, and that thing worked fine. For the observing telescope I borrowed from my older brother, an army surplus, which I hooked onto an old stand, which I got from the junkyard. After it was sandpapered and cleaned up it looked like new. They charged me 10 cents for it, and it looks like $10.00 now.

The prism which I use is what they call a 90° prism. I know I really need a 60° prism, but the one I ordered from a magazine has never come. It will give a much better spectrum, and I hope it still arrives before the show starts. I ordered it three weeks ago, and it should have been here long ago, and I never will buy anything from that outfit again. That 90° is one daddy had, and I mounted it on a rotator, that comes from an old radio. You know that thing that is used to push that radio dial over the stations. Over the prism, I placed an old candy can of which we have a basement full. It was painted black to keep reflections down.

Finding the focal length

One of my main problems was to find the focal length of that Convex lens for the Collimator. The first thing I did was to mount the lens so that I could move it forth and back. Then I took a clean sheet of paper and taped it onto the wall. Behind the lens I placed a light bulb with the top facing the lens. Then I focused the lens so that I could see clearly the printing "Ken-Rad 100 watts 120 V" on the sheet of paper. The rest was easy. All I had to measure the inches from the lens to the wall, and I had the focal length.

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[1]While judging at the State Science Fair of our Junior Academy, the undersigned was particularly taken with the written report accompanying the physics entry of Lawrence Schrage, age 13, of Gainesville Junior High. With the author's permission it is reproduced here, for the sheer pleasure it will give the reader. Larry's spectroscope won a ribbon, and his writing style is equally a prize-winner.—Wm. H. Jones, President, 1957-58.

Mounting the lens

I mounted the cardboard tube for the Collimator onto the 2 x 4 with straps of copperband, which I got from our plumber. Then I placed the Slit the same distance as I had measured on the wall, and that should keep it in focus. Then I glued the prism onto the rotator which was in the candy can. Then I made the lamp housing from an old cangoods can, into which holes were punched with a can opener, so that it would not get hot. Then the lamp was mounted on a 2 x 2 which just did fit into the can when strongly pushed. Then I turned on the lamp and held a piece of paper in front of the prism, and the thing did not work. I was just heartbroken, and was trying to find out what was wrong when I saw the Spectrum on the wall which was just off the side of the spectroscope. Thus I found out how I could get it onto the piece of paper. All I had to do was to hold it to the side of the prism. There was only one thing wrong the lines were not sharp enough. Later on I found that if I reset the telescope the lines would look alright. After I found the right spot for the telescope, I took a piece of plywood and mounted the telescope on it. That piece of plywood was cut so that it would fit right onto the other parts, and would hold it together, now I do not have any trouble with this anymore.

Directions

For light source use the shiny can, which contains the bulb and can be plugged into any wall socket. Make sure that the two boards which are the base of the Collimator and the viewing Telescope are pushed together.

In order to test different materials you use the electric arc lamp. It consists of a 1000-watt heater element, and two pieces of carbon. Place the matter to be tested into the hollow atop the lower carbon. Then touch the carbon sticks together, and spread them apart slowly. Look into the spectroscope, and see what colors it is made of. The different colors stand for different compounds. For instance Sodium produces a yellow line. Hydrogen produces red, yellow, green, as well as small lines of blue and violet.

JAMES R. STOKES—1900-1957

The sudden death on November 11, 1957 of Dr. James Stokes, Professor of Biology and Chairman of Science and Mathematics at G.S.C.W., came as a shock to his colleagues, his students, and particularly to his many friends and associates in the Georgia Academy of Science.

Dr. Stokes was born in Walterboro, South Carolina, received his B.S. degree from the University of Georgia in 1922, his M.S. degree from the University of Wisconsin in 1928 and his Ph.D. degree from the University of Chicago in 1937.

His entire teaching career was spent in Georgia. He taught first at Gordon Institute in 1922-23, then joined the staff at Georgia State Woman's College in 1923, becoming Professor of Biology in 1928. During his tenure in this position from 1928-1935 he made extensive studies on the cytology of Myricaceae, so abundant in the region. In 1936 he was appointed Professor of Biology and Head of the Department at Georgia State College for Women. In 1946, he was appointed Chairman of the Division of Natural Sciences and Mathematics, which position he held until his death in 1957.

Dr. Stokes was a member of the Georgia Academy for many years, serving the Academy as a council member and as Vice President in 1950. He was seldom absent from the annual meetings and served as an efficient host when the meetings were held at Milledgeville.

A popular and dynamic teacher, with a keen sense of humor, Dr. Stokes had the ability to put ideas into forceful language and exerted a tremendous influence on his students.

His interests were varied and the charm of the out-of-doors led him into the field on many excursions, while the growing of prize-winning camellias brought him pleasant recreation and gave much pleasure to his friends. Those of us privileged to be with him on camping trips to the Okefenokee Swamp will long remember his congeniality his enthusiasm and his friendly cooperation in all activities.

In addition to his membership in the Georgia Academy, Dr. Stokes was a member of the Botanical Society of America, Association of

Southeastern Biologists, and the American Association for the Advancement of Science.

Dr. Stokes leaves not only a living memorial in the persons of his many students, but will be remembered on the G.S.C.W. campus by reason of the well-planned and equipped Science Building which was erected during his Chairmanship of the Division of Natural Sciences.

—W. B. BAKER, *Historian*

RESOLUTION FOR DR. JAMES STOKES

WHEREAS:—

The sudden death of Dr. James Stokes on November 11, 1957 took from us a loyal member of the Georgia Academy of Science; and

WHEREAS:—

The contributions made by Dr. Stokes to the advancement of Science in Georgia during his teaching career in the state from 1922 until his death in 1957, will remain as a monument to his memory;

WHEREAS:—

During his long membership in the Academy he served in many capacities, being on the Executive Council, serving on various important committees, and as Vice President for one term, filling each position with enthusiasm and ability;

WHEREAS:—

On the occasion when the Academy held its meetings in Milledgeville, Dr. Stokes proved to be a most genial host, providing effectively for all needs of his guests;

WHEREAS:—

With his passing the faculty and student body at Georgia State College for Women lost one of their most popular and enthusiastic colleagues and teacher;

BE IT RESOLVED, THAT

The Georgia Academy of Science extend to his family and associates our sincere sympathy and that these resolutions be spread on the minutes of the Academy and a copy be submitted to Mrs. Stokes and President Robert E. Lee of Georgia State College for Women.

THE DESTRUCTION OF MENDELIAN GENETICS IN THE SOVIET UNION[1]

R. Harold Brown and A. A. Fleming[2]
University of Georgia

INTRODUCTION

A complete change in the conception of heredity apparently has been brought to Russia as a result of the struggle between two opposing factions. Beginning about 1930 the biological scienitsts of that country were divided into two groups over the subject of heredity. The group which seems to have emerged victorious was at odds with the biologists outside of Russia and countries under Soviet control.

The news of the controversy in Russia was unexpected in the outside world and amazed geneticists and other biologists in the non-Soviet countries. Conway Zirkle (1949), Professor of Botany at the University of Pennsylvania, said, "At a time when the prestige of science is greater than ever before and when the benefits of scientific research are known to everyone, it seems incredible that a science should be destroyed in a country reputedly civilized and scientists therein be forced to recant. If we consider further that the science destroyed was genetics at the very time it was making practical contributions to agriculture on an unprecedented scale, the event approaches the fantastic."

A discussion of Soviet genetics, in view of recent controversies, must of necessity be of a non-scientific nature. Scientific questions and genetics in particular were, however, involved in the controversy.

The cause of the rise of anti-Mendelian views in Russian genetics is not well understood. The reason for the acceptance of these views is probably manifold. The German Nazis, who had a distorted conception of genetics, that is, the race supremacy of the German people, were at that time hostile to the Russians. The Communist doctrine as dictated by Stalin's government favored the anti-Mendelian biologists. Lysenko, leader of the anti-Mendelian group of biologists, and his followers became politically powerful. Any or all of these factors likely played a part in the change in Soviet genetics.

In defending his views, Lysenko is prone to using words and phrases in attempting to prove his statements. His assertions are almost never accompanied by scientific data. Likewise, his condemnations of Mendelian genetics are presented in the form of verbal attacks using derogatory adjectives such as "metaphysical," "capitalistic," "reactionary," etc.

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[1]Contribution from the Department of Plant Pathology and Plant Breeding, University of Georgia, Athens, Georgia. A term paper submitted by the senior author in partial fulfillment of the requirements for completion of the course, Plant Genetics (PAT 401), during the winter quarter of 1957.

[2]Student and Associate Professor of Plant Breeding, respectively.

The controversy over genetics in Russia and its outcome are to be considered grossly detrimental to science. It stands as an example of what can happen to a science when it is controlled by political pressures instead of free experimentation.

Soviet Genetics Prior to 1936

Before the genetics controversy, which began in the early 1930's, Russian genetics enjoyed a prosperity equal to that of any country in the world. N. I. Vavilov was the most famous Russian geneticist. His contribution to genetics in the Soviet Union is tremendous.

Nikolai Ivanovich Vavilov was born in 1887, a son of a wealthy merchant. Vavilov had a brother, Sergei, a physicist who in 1947 was President of the Academy of Sciences of U. S. S. R. The young Vavilovs had the best education that money could purchase (Dobzhansky, 1947). N. I. Vavilov graduated from the Agricultural Academy at Petrovsko-Razumovskoe, and continued his education and research at Cambridge University in England. There he became a close friend and student of William Bateson. In 1913 and 1914 he worked at the John Innes Horticultural Institute, which was founded and organized by Bateson. Even before he went to England, Vavilov studied the immunity of cereals to fungus diseases and published several papers on this subject.

After his return to Russia at the start of World War I, Vavilov started his monumental work on the origin of cultivated plants. It was his most important research contribution, a classic study published in 1926 in a book, "The Centers of Origin of Cultivated Plants." Chester translated it into English in 1951.

In 1920, Vavilov was placed in charge of the Bureau of Applied Botany in Petrograd. In a few years, the All-Union Institute of Applied Botany and New Crops as the Bureau was then called, became the center of a federation of agricultural institutes distributed all over the U.S.S.R. The combined staff of these institutes in 1934 amounted to about 20,000 persons. Vavilov was made a member of the Soviet's Central Executive Committee, a body somewhat similar to the American Senate. He was one of the very few noncommunist members of the Committee. In the 1920's, while one of the most influential persons in the U.S.S.R., he lived in his office at the Institute of Applied Botany. An old leather covered davenport served as his bed.

In his search for genetic material, Vavilov and his colleagues visited approximately 60 countries in all parts of the world. The scientific and practical value of his collection is beyond estimate. In 1930 and 1932-33 he traveled extensively in Mexico and in Central and South America.

While visiting Sequoia National Park in October of 1930, Vavilov remarked to Th. Dobzhansky, who was the only person accompanying him, that opportunities for serving mankind which existed in the U.S.S.R. were so great and inspiring that for their sake one must learn to overlook the cruelties of the regime (Dobzhansky, 1947).

Besides Vavilov there were several other geneticists who made valuable contributions to genetics in Russia. In 1898, Navashin discovered double fertilization in higher plants. Th. Dobzhansky, an outstanding geneticist, is a native of Russia and is now working in the United States. Other names important in Soviet Mendelian genetics are: N. P. Dubinin, B. S. Chetverikov, G. D. Karpechenko, J. J. Kerkis, N. K. Koltzov, Serebrovski, and Levitzky. There are still others of more or less importance.

A name that was mentioned frequently in the genetics controversy was that of I. V. Michurin. Michurin, as a commercial plant breeder, began his work about 1887. He is most noted for his work with "vegetative hybrids." As Darlington (1947) stated, Michurin claimed that by grafting, it is possible to train a plant for crossing, or to improve the quality of the result of crossing. Michurin's "vegetative hybrids" were actually not hybrids at all.

The achievements of Michurin were undoubtedly of some value, but he did not apply scientific methods to his work. Hence it cannot be analyzed. Stalin was so pleased with Michurin's work that he named a town, Michurinsk, in his honor. Michurinism did not end, however, when Michurin completed his work. It was adopted and wholeheartedly supported by Lysenko and his followers.

Trofim D. Lysenko was born in 1898 to a peasant family living in the province of Poltava. He entered the Horticultural Institute of Poltava in 1913. From there he went to the Umansk Institute of Horticulture where he remained until 1921. After acquiring experience as a plant breeder at Kiev, he was appointed to the newly founded research station of Gandza, where he began experiments on vegetative periods. From these investigations, Lysenko arrived at his theory of phasic development which, together with the technique of vernalization, brought attention to him.

In 1929, Lysenko explained his principles to the Congress of Genetics, Plant and Animal Breeding, in Leningrad. In his vernalization work Lysenko tried to link heredity with the process of vernalization. He claimed that the effects produced by vernalization were inherited. Actually Lysenko was not the discoverer of vernalization. In 1837 an anonymous person from Tennessee published in "The Cultivator" (Vol. 4, No. 4, p. 64) a method for sowing winter wheat in the spring. The process consisted of soaking the winter wheat and freezing it. The wheat kernels were to be kept frozen, as far as practical, until sowing time in the spring. In 1846, Richard L. Allen in the United States discussed the same process and in 1858 J. H. Klippart added the suggestion of sprouting the kernels before freezing (Zirkle, 1949).

The vernalization process did not come into common use in the United tates. There is some doubt as to whether it was used very widely in Russia. Most of Lysenko's theories are either not his own or are completely incompatible with science outside the U.S.S.R. In view of his work it is incredible that he and his followers replaced the Mendelian geneticists in Soviet agriculture.

The Ascent of the "New Genetics"[3]

Lysenko's popularity mounted after his report to the Genetics Congress in 1929. His criticism of formal genetics was hardly detectable at that time. His following was not large enough for him to appear extremely radical that early.

In 1924, when Lenin died, the leadership of the U.S.S.R. fell into the hands of Josef V. Stalin. How large a part Stalin played in the downfall of genetics is not clear. He was complete dictator during his reign and was considered by some to be a warped-minded individual. Regardless of the role that Stalin played in the controversy, it was during his regime that the downfall of Mendelian genetics took place.

The dismissal of geneticists began in 1932 when G. A. Levitsky, a cytologist, and his student N. P. Avdoulov, were sent to labor camps. Vavilov asked Stalin for their release, which was temporarily and grudgingly granted. At the same time B. S. Chetverikov, the pioneer of population genetics, and W. P. Efroimson were sent to Siberia. Nothing was heard of them for fifteen years. In 1935 I. J. Agol and L. P. Ferry were the first two geneticists to be put to death (Darlington, 1947).

Zirkle (1949) quotes a news dispatch of December 14, 1936, as being captioned by the bold lettered words which read in part: "Moscow Cancels Genetics Parley . . . Nazi Racist Theories Ascribed To Some Scientists Cause Dropping of World Congress . . . Americans Were To Go . . . Prof. N. I. Vavilov, A Famous Plant Expert Is Arrested . . . Others Under Attack. . . .

The report of Vavilov's arrest arose through a mistake in the transmission of the dispatch, according to the New York *Times*.

The Seventh International Congress of Genetics was to have been held in Moscow in August, 1937. Preparations were well advanced when news came of the cancellation. The reason for the cancellation was believed to have been the fact that so many of the prominent Russian geneticists were under fire.

On December 22, 1936, the New York *Times* carried an article in which the Russians defended the delay of the Congress. Izvestia, the chief government organ, stated that the only object of the postponement was to guarantee the best preparation and the utmost participation of scientists of various countries in its work. No intimation was given when the "postponed" Congress would be held.

Pravda denied the arrest of Vavilov. It admitted the arrest of Professor Agol for contact with "Trotskyist murderers."

Vavilov wrote a statement for the New York *Times* on December 22, in which he criticized the foreign press for trying to discredit science in the U.S.S.R.

On December 28, another item in the New York *Times* indicated that classical genetics was under heavy fire in Russia. Lysenko of

[3]The word "genetics" implies the gene theory; however, in this paper it is used to indicate "heredity" in some cases, where the gene theory is not accepted.

the Odessa Institute criticized Vavilov for failure to take into account the experimental data on the production of new varieties of plants through intervariety crossing on 15,000 collective farms. Vavilov, on the other hand said that the Odessa Institute had not obtained sufficient experimental data. Genetics (Mendelian) was criticized for failure to find a place in its classification for the work of Michurin and Lysenko.

As Zirkle says, "Lysenko had started only a skirmish, however, and classical genetics would not be seriously hurt for three more years."

The International Genetics Congress planned for 1937 in Russia was held during the week of August 23-30, 1939, in Edinburg, Scotland. World War II had just begun and the German geneticists who were allowed to attend, were recalled before the sessions were over. Of the Americans who attended, a few were returning on the ill-fated Athenia, the first liner to be sunk in the war. It was torpedoed in mid-Atlantic.

Vavilov had been elected President of the Congress and had accepted the honor. Later he declined, since none of the Russian geneticists were allowed to attend. Russia did not become involved in the war until nearly two years later.

In the short time of less than six weeks after the International Congress ended, the Russians held a congress of their own. It met from October 7-14, 1939, in Moscow. Fifty-three members participated in the discussions. Three of the speeches have been republished in English by a Russian publication, Science and Society (1940). The three chosen for translation were those of Vavilov to represent the geneticists, Lysenko to represent the Michurinists, and I. M. Polyakov, who took an intermediate position. Vavilov's speech was perhaps one of the poorest he ever made. It is well to consider in this connection that his arrest was only ten months in the future. He saw how things were going and knew he was losing.

M. B. Mitin, Head of the Philosophical Institute of the Academy of Sciences, gave a supposedly "balanced judgment of the contending parties" in his evaluation of the Congress. In it he praised Lysenko repeatedly and attacked Vavilov's position by insinuations and actual falsehoods. Mitin held high rank in the party that controlled Russian politics.

The arrest of N. I. Vavilov had been erroneously reported as early as 1936. Geneticists outside of Russia had for some years been unable to get in touch with Vavilov. The account of his actual arrest is made possible by information received by Th. Dobzhansky. Although the information is not completely clear and confirmed, a fairly accurate account can be drawn from it.

Zirkle (1949) gives the following: "In the summer of 1940 Vavilov organized an expedition to Galacia and Bukowina, then occupied by Russia." The object was to collect indigenous agricultural plants before they were replaced by Russian varieties. The expedition was organized at Kiev, but was sabotaged and delayed by local officials who knew that Vavilov had fallen from grace. The expedition finally

started and reached Lvov. "The personnel was divided into several groups, which went into various parts of the territory to be studied." News soon reached the collectors that Vavilov had hurriedly left for Moscow. His absence was unexpected since he was supervising the work closely. In a week or so the groups came together and learned, via the grapevine, that Vavilov had been arrested and was not expected to return soon. The expedition was abandoned.

The date of Vavilov's arrest is August 20, 1940, plus or minus a week according to Zirkle. Part of the time during the winter of 1941-42, he was a prisoner at a concentration camp at Saratov. From there he was transported to Siberia. Dobzhansky (1947) says, "His destination was Magadan, on the Sea of Okhotsk, the capital of a rich gold-bearing region, but a place of sinister reputation because of its deadly climate and even worse because it was built and operated by forced labor." Vavilov met his death on the bleak shores of this Siberian sea in 1942. Vavilov's name was not found on the list of living or deceased members published by the Academy of Sciences of U.S.S.R. in 1945.

In 1942, Vavilov and his closest cytological colleague, G. D. Karpechenko died ("in the fighting" so it was said). About the same time J. J. Kerkis, the Drosophila geneticist, disappeared and Levitsky was sent back to a labor camp where he died (Darlington, 1947).

In thirteen years the great fellowship of Russian biological research had been crushed and broken. Those who wonder why, that in the closing stages of the genetics trial, these men lost their nerve should consider that they knew the methods of the Soviet Government and could foresee their own destruction.

In 1948, Academician T. D. Lysenko made a lenghty speech before the V. I. Lenin Academy of Agricultural Science in which he restated his views of heredity in connection with plant breeding. In this speech he showed more vigor and assurance than in that of the 1939 Congress. The report of Lysenko occupied the first session of the Lenin Academy. During the next seven days fifty-six speakers were heard. In the following sessions only seven of the fifty-six defended Mendelian genetics. Those who did, discarded so much of their views that it was obvious they were badly frightened and hoped at best to save only a few fragments of their science.

The Michurinists, as Lysenko's group was called, on the other hand were confident and aggressive. The nature of Lysenko's speech can be illustrated with the following excerpt: "The chromosome theory of heredity may seem systematic, and perhaps in some certain degree true, only if we ignore the fundamental ideas of Mendelism-Morganism, and people not acquainted in detail with the life and development of plants and animals may be deceived by it. To refute it, we have only to assume as an absolutely true and well-known fact that the sex cells or rudiments of new organisms are produced by the organism itself, by its body and not by the sex cells from which the mature, parental organism arose. This completely upsets at one stroke all of the 'systematic' chromosome theory." To refute an unwanted theory, Lysenko here finds is necessary only "to as-

sume" a competing hypothesis "as an absolutely true and well-known fact." (Zirkle, 1949).

The criticism of Mendelian geneticists in the Soviet Union was severe. Says Lysenko, "An example of how far our native Mendelists-Morganists uncritically accept idealistic genetics is the fact that until recently the basic textbook on genetics in many of our higher institutes of learning is a translation of the strictly Morganist American textbook of Sinnott and Dunn."

An indication of the part that politics played in Soviet genetics is given by Lysenko in his talk. "Until the present time they (the Michurinists) have even been in the minority in the membership of the V. I. Lenin All-Union Academy of Agricultural Sciences. Thanks to the care of the Party, the Government, and personally of Comrad Stalin, the situation in the Academy has now been radically changed."

In his speech Lysenko again reiterated his "vernalization" work to prove his theory of the inheritance of acquired characters. He also spoke of graft hybrids as a means of breeding better hybrids.

The 1948 meeting apparently was the final blow for Mendelian genetics in Russia.

Will Mendelian Genetics Return to Russia?

The overwhelming victory of Lysenko in 1948 did not put a complete quietus on the controversy. There seemed to be no limit to the absurdity with which Lysenko and his group would make their claims. The following quotation from a paper by Lysenko (1950; published in Journal of Heredity in 1956) shows the complete indigestability of his works. "In 1949, on the basis of these experiments, a number of scientists and agronomists proved beyond the shadow of a doubt that in the foot hills and mountainous regions, in regions where winters are severe, and especially in fields where conditions are unfavorable to development, winter wheat may be converted into rye."

It is well to remember that Lysenko's rise was during Stalin's reign as dictator. The year before Stalin died, the first attack on Lysenko's claims, since the fall of classical genetics, was made by N. V. Turbin, who is himself a Michurinist. He had been a supporter of Lysenko in 1948. Turbin had accepted most of Lysenko's claims about transforming one species into another, but he could not accept the statement that pine evolved into spruce and hornbean into hazel.

Another Michurinist, N. D. Ivanov, also attacked Lysenko. Ivanov even criticized Lysenko's recent theories for their Mendel-Weismann-Morganist content.

Neither Lysenko nor his opponents were without supporters. But, the situation seemed to develop in favor of the anti-Lysenko group. Press dispatches from Moscow dated April 10, 1956 contained news that Academician Trofim Denisovich Lysenko had, at his own request, been relieved of his duties as President of the All-Union Lenin Academy of Agricultural Science (Zirkle, 1956).

The reason for Lysenko's resignation is not clear. Some of the possible reasons are: (1) Stalin's successors, perhaps, were not as well pleased with Lysenko as Stalin was; (2) Lysenko's methods were not producing as anticipated; (3) a Russian delegation to the United States, led by Valadimir V. Matskevic, found American agriculture superior to their own.

According to Zirkle (1956) the Russians imported 500 tons of hybrid seed corn from the United States. The imports consisted of 20 different hybrids for testing in their country.

Lang (1957) points out that breeding of hybrid corn (in the "Western" sense) was completely abandoned in the U.S.S.R. for more than 10 years, under the influence of Lysenko. In 1947 some work was resumed by using inbreds obtained from the United States. The work even met with opposition then, for in 1949 "an All-Union Conference on Corn Breeding, held at Odessa, endorsed Lysenko's method and condemned the use of inbred lines."

The future of genetics in Soviet Russia is uncertain. A prediction concerning the future of this science or any science in Russia must take into account the fact that the final decisions will not be made by men in the field of science.

On April 2, 1956, Moscow news dispatches announced Dr. N. I. Vavilov's "scientific resuscitation." Vavilov rendered a tremendous service to Soviet science and agriculture. His death in Siberia in 1942 was one of the most vicious attacks on science by any government in history. The work to which he devoted his life caused his death. Scientists and laymen the world over will do well to remember the fate of Nikolai Ivanovich Vavilov—a martyr of genetics.

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REPORTING X-RAYS IN 1896

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An authentic report on how the engineering class at the University of Georgia received the news of the discovery of x-rays. This is mainly a newspaper account, as kept in a scrapbook by the class, telling how the news was received and how it developed locally and nationally, with some rivalry among nearby institutions.

The Electrical World, February 1, 1896. *Dark Light Photography,* by C. J. Reed. "The results recently alleged to have been obtained by Professor Roentgen in photographing without light, instead of being received with surprise, should have been predicted long ago as likely to follow, from certain physical facts that are well established. It is entirely unnecessary to invent or assume the existence of any new or 'strange medium' in order to explain such results. The reported discovery by Professor Roentgen of a method of photographing by waves of a range to which glass and the human eye are perfectly opaque, and to which metals and human flesh are transparent—waves which he has been able to produce by means of an induction coil—is not only reasonable, but capable of easy explanation without the creation of new medium. Should the reports of this discovery be confirmed we cannot fail to accord the highest praise to this new triumph of science, and to predict a development of the new field of actinography that may prove of greater importance than photography. From the analogy between this form of radiant energy and dark heat it might appropriately be called *dark light.*"

New York Herald, February 2, 1896. "WITH CATHODE RAYS. PROFESSOR TROWBRIDGE'S EXPERIMENTS IN THE LINE OF PROFESSOR ROENTGEN'S DISCOVERIES. SEEKING SHARP SHADOWS. HE BELIEVES THAT IN TIME THE ORGANS OF THE BODY WILL BE PLAINLY PHOTOGRAPHED. DO NOT ALWAYS ACT THE SAME. SOMETHING ABOUT THE RAYS WHICH STILL REMAINS TO BE DISCOVERED BY SCIENTISTS. So great is the public interest in the experiments that are being made with the cathode rays by Professor Trowbridge, director of the Jefferson Physical Laboratory of Harvard College, that he has found it necessary to deny himself to many callers. He thinks that by the employment of uranium instead of glass for the tubes, far more satisfactory results will be reached, and he recommends the use of an aluminum window in the tube. Uranium gives off a greenish yellow and greater fluorescence than is possible to obtain from glass alone. Professor Trowbridge will continue experimenting with the hope of finding the cathode ray in ordinary air—that is, outside of a vacuum. He has already attempted to show the presence of the ray in a glass vessel in which there was two inches of air pressure. A result was found on a very small circular sensitive plate, but it was irregular and not distinct."

New York Tribune, February 2, 1896. "CATHODE PHOTOGRAPHY. FOLLOWING UP ROENTGEN'S STARTLING DISCOVERIES. GREAT POPULAR INTEREST EXCITED BY THEM IN THIS CITY AND ITS VICINITY. THE LATEST RESULTS. PREPARATIONS FOR FURTHER RESEARCH. CROOKES TUBES IN DEMAND. GOOD WORK AT YALE. The startling story which came to this country from Germany three or four weeks ago, about the possibility of photographing the interior of a human body without showing the exterior, by means of a newly discovered radiance, was generally received at first with much incredulity. People recalled the wish of an eminent essayist, inspired by sultry summer weather, that he could take off his flesh and sit in his bones, but discredited the idea that the 'new light' would depict a person living in that airy costume. At Yale Professor A. W. Wright, filling the chair of experimental physics, secured some rather satisfactory results last week. Experiments with human subjects, however, possess the most fascination for the popular mind, if not for the scientists. One German expert is said to have photographed his own skull, taking a profile view. The bone obstructed the passage of the light so as to outline the form of the whole cranium fairly well, but the fleshy coverings were so imperfectly outlined as to be practically invisible. There is no evidence, up to date, though, that the cathode ray will tell what is going on inside a man's knowledge box, and it may be that we shall still be able to keep some secrets to ourselves, even if our purses and bodies are not proof against the new inquisitor. Since the first surprising news of Roentgen's work was received in this city, Nikola Tesla, the distinguished electrical expert, has been repeatedly asked to talk of the subject for publication. This, however, he steadfastly refuses to do, not because of any hostility to the Bavarian whose name is now in every one's mouth, but because it is his uniform practice to decline to grant a newspaper 'interview.' Mr. Tesla's admirers recall, however, that in *The Century* for last April, in an article from the pen of Thomas Commerford Martin, that there were reproductions of two striking photographs. These represented Mr. Tesla's own face and that of Samuel L. Clemens (Mark Twain), and were taken with the phosphorescent glow emitted by a vacuum tube of a different character from that which bears the English chemist's name. But when the method of exciting the light is considered, it may be found that there is a close relation between Mr. Tesla's "phosphorographs' and the strange products of the Roentgen ray."

Washington, February 1, 1896. "THE NEW PHOTOGRAPHY. ARMY AND NAVY OFFICIALS PREDICT VALUABLE RESULTS FROM ITS USE IN THEIR WORK. Army and Navy ordnance officials are deeply interested in the wonderful achievements in photography attributed to the Roentgen light, by which conditions prevailing throughout the interior of solids are accurately depicted, as in their opinion it will revolutionize the methods now in vogue for the inspection of armor and gun materials, obviating

any possibility of contractors foisting blow-holes, plates and other internally defective materials upon the Government."

European Edition of the *New York Herald*, Paris, January 27, 1896. "FRENCH STUDIES OF ROENTGEN'S RAYS. EXPERIMENTS BY PARIS SCIENTIST IN PHOTOGRAPHING THROUGH OPAQUE BODIES. REMARKABLE CASE IN LONDON, A PARALYZED SAILOR QUITE CURED, THANKS TO THE NEW DISCOVERY. Professor Roentgen does not consider, however, that the regions of the stomach, the loins and the heart can be photographed by means of these rays, the credit for the discovery of which he says must be given to M. Menard, the Hungarian scientist. Up to the present the most wonderful use made of this discovery is reported in *The Lancet*. A sailor who was brought to Guy's Hospital has been completely cured of paralysis. When admitted he was dead drunk, and had been found in a very dangerous condition in one of the worst quarters of London. As soon as his drunken fit was over it was discovered that he was paralyzed in the upper and lower parts of his body. The most minute examination could reveal nothing but a small wound in his back by the side of the vertebral column, which in a few days was healed. During this time and despite all medicine, the man remained paralyzed. Then Dr. Williamson was struck with the idea of employing the new photographic discovery. A photograph, following Professor Roentgen's system, was taken of the man's wound. The negative showed the presence of a foreign body, the nature of which could not be determined, between the first dorsal vertebra and the first lumbar vertebra. An incision was made at this place, and after a great deal of difficulty the blade of a knife was taken out. The patient immediately improved."

New York Herald, February 9, 1896. "IT MAY RESTORE LIFE. RESULT OF AN EXPERIMENT. A MOUSE THAT HAD BEEN UNDER WATER FIFTEEN MINUTES REVIVED UNDER THE INFLUENCE OF THE RAYS. NEW NAME FOR THE SHADOWS. MR. OSTERBERG SAYS THE PICTURES SHOULD BE CALLED SKOTOGRAPHS, NOT CATHODOGRAPHS. Others have named it cathodograph. That is positively wrong, since these Roentgen rays are only produced by the cathode."

New York Herald, February 9, 1896. "TUFTS HAS A PIONEER. PROFESSOR A. E. DOLBEAR EXPERIMENTED WITH CATHODE RAYS AS LONG AGO AS 1892. Tufts College ranks among the first American colleges in the completeness of its electrical laboratory. Professor A. E. Dolbear, who is at the head of the department of instruction, is a pioneer in electrical investigation, and not only experimented with cathode rays as long ago as May 1892, but also published an account of the results, with an explanation of his theories, in a well known scientific magazine, under the title of 'Electricity and Photography.' In these experiments he secured a distinct photograph of an iron star on an ordinary sensitized photographic plate, through a board over an inch in thickness."

New York Herald, February 9, 1896. "DIFFERS WITH ROENTGEN. PROFESSOR MICHELSON HAS MADE A THEORETICAL STUDY OF THE SUBJECT. Professor Michelson, head of the department of physics in the University of Chicago, has as yet made no experiments with Professor Roentgen's discovery, but will conduct some shortly. He says he has made a theoretical study of the subject, and has reached conclusions at variance with those of Professor Roentgen regarding the character of the light. 'The experiments I propose to make may be of little popular interest,' said Professor Michelson, 'as I do not expect to continue the practical application of the discovery. Professor Roentgen holds that it is neither ordinary rays of light nor cathode rays, but I think it is one particular class of cathode rays.' 'What facilities have you, Professor, in your laboratory for conducting experiments?' 'None that are particularly noteworthy.' 'What money will be appropriated for the purpose?' 'There will be no appropriation at all.' "

New York Herald, February 9, 1896. "INTERESTED IN AMHERST. PROFESSOR KIMBALL OF THE DEPARTMENT OF PHYSICS, WILL BEGIN EXPERIMENTS. Professor Arthur L. Kimball, of the department of physics, in Amherst College, will begin experiments at once examining into the remarkable properties of the cathode rays investigated by Professor Roentgen. Amherst's laboratory is well provided with all the necessary apparatus to carry on researches in that direction, and although no special appropriation has yet been made by the college for the investigation, there is no doubt that whatever money is required to carry on the work will be provided. Dr. J. O. Thompson, Professor Kimball's assistant, will help as much as his classes will allow him."

New York Herald, February 7, 1896. "TO PHOTOGRAPH A MAN'S BRAIN. STARTLING EXPERIMENTS EDISON MEANS TO TRY AT HIS LABORATORY IN ORANGE TODAY. HIS LABORS HAVE ALREADY RESULTED IN A DECIDED IMPROVEMENT ON THE CROOKES TUBES. ALL COLLEGES INTERESTED. PICTURING OF THE INVISIBLE GOING ON AT COLUMBIA, NEW YORK CITY, AND PRINCETON. Unless his plans miscarry, Thomas A. Edison will endeavor today to make a photograph at his laboratory in Llewellyn Park, Orange, N. J., of a man's brain, with the aid of the lately discovered Roentgen rays. When I visited Mr. Edison's laboratory yesterday I found the Wizard highly elated with the results he had thus far obtained from experiments with the Roentgen rays, or x-rays, as Professor Roentgen himself has named them, because they are mysterious. Mr. Edison said that, while he was satisfied that Professor Roentgen had opened up a new and interesting field to the scientific world, he still thought he would not realize much from his invention when the importance of the discovery is taken into consideration. He said he had been trying to find some commercial value for the discovery that would bring in cash returns. Speaking again of his tubes, Mr. Edison said: 'When I began to look into Professor Roentgen's discovery, I had here and there in the laboratory fully a dozen Crooke's

tubes which I had bought several years ago. I soon turned these out and decided that we could make them ourselves. The results we have obtained are satisfactory, and two men are now at work turning out the tubes by the dozen.' 'Professor Roentgen' said the Wizard, 'will probably never realize a dollar from his discovery. He is one of that class of pure scientists who study nature's mysteries for the love of knowledge and experiment, and after they have produced something wonderful some fellow like me, who views such things from a commercial standpoint, comes along and turns it to practical account. That is the condition of Dr. Roentgen's discovery. It is a wonderful one, but we have now got to find out what it can be utilized for and give it a place and value in the commercial world.' The professors and students at Princeton college have taken a deep interest in Professor Roentgen's discovery, and already have made experiments with the cathode rays. Professor William F. Magie, chief instructor of physics at the University, has been making experiments. 'But the discovery can never, it is believed, be of use in medicine, in experimenting with the internal organs of the human body, in as much as the degree of opacity of the tissues is largely undifferentiated. The brain could not be photographed because of the fact that the skull is much more opaque than the brain, and the rays of light would penetrate the brain and show nothing but the skull.''

New York Herald, February 7, 1896. ''A PROFESSOR IN JOHNS HOPKINS UNIVERSITY NOT SATISFIED AS TO THE VALUE OF THE DISCOVERY. Experiments are now underway in the Johns Hopkins University on the line of Roentgen's light researches. The results thus far secured have not justified Professor Henry A. Rowland, under whose supervision the experiments are being conducted by a graduate student, Norman Ross Carmichael, in making any positive statement as to the real value of the discovery.''

New York Herald, February 18, 1896. TAKEN WITH CATHODE RAYS. PROFESSOR PUPIN'S REMARKABLY CLEAR PHOTOGRAPH OF THE BONES OF THE HAND. ROENTGEN'S BEST EQUALLED. It is understood that as a result of his highly successful experiments in photographing with x-rays by Professor Pupin, in the laboratory of Columbia College, apparatus for the use of this new aid to surgery is to be installed in the Presbyterian Hospital and in the College of Physicians and Surgeons, in West Fifty-Ninth Street. UNION HAS FACILITIES. But the experiments have not been quite as successful as could be wished. Professor Perkins and T. W. Wright, who have charge of this branch of collegiate work, express themselves as satisfied with their facilities for conducting the necessary experiments. NO SUCCESS AT BROWN. Professor Barrows, of Brown University, says that he has not made any experiments with Professor Roentgen's discovery, but that his assistant, Dr. Palmer, has done so. Owing to the limited apparatus on hand, good results were not obtained.''

New York World, February 18, 1896. "PATIENTS UNDER X-RAYS. TESTS MADE WITH HOSPITAL INMATES IN DR. MORTON'S LABORATORY. INNER STRUCTURE OF ARTHUR THORP'S ARM SEEN, BUT TOO DIMLY FOR A DIAGNOSIS. Important experiments to test the value of the Roentgen x-rays in the field of surgery were made yesterday in the laboratory of Dr. William James Morton, at No. 19 East Twenty-Eight Street."

New York World, February 18, 1896. "QUEEREST TEST OF X-RAYS. IMAGES CAST ON BRAINS OF ANIMALS INFLUENCE THEIR ACTIONS. Of all the experiments made in connection with the x-rays, the oddest are now being quietly conducted, it is reported, in the physiological laboratory of the College of Physicians and Surgeons in West Fifty-Ninth Street. In one experiment a bone lying in an out of the way corner was photographed. The shaven skull of a dog was exposed to the influence of the picture by means of the x-rays. On being released the dog immediately hunted up the bone, showing there was an image of it on his mind. BOY'S BRAIN PICTURED. DR. F. S. KOLLE SUCCEEDS IN GETTING A SHADOW BY THE USE OF THE X-RAYS. THE EIGHT MINUTE EXPOSURE TO BE INCREASED AND THE APPARATUS MADE BETTER."

The Atlanta Constitution, February 16, 1896. "FIRST X-RAY PICTURES BROUGHT TO ATLANTA YESTERDAY. PROFESSOR McKISSICK, OF AUBURN, MAKES A SUCCESSFUL EXPERIMENT. PRODUCED THE STRANGE LIGHT. The new photography is here. *The Constitution* presents this morning one of the most successful series of pictures yet taken in America by the new light and the only pictures of the kind that have been taken in the South. 'My experiments demonstrate one thing about which I have seen little in print. That is while this light will penetrate wood, leather, celluloid, and other solid substances it will not pass through glass. A property of these rays which may probably be brought into use is that they are capable of being deflected by a magnet and this fact might be the means of our concentrating the light.'"

The Atlanta Constitution, Athens, Georgia, February 18, 1896. (Special) "CLAIM TO BE FIRST. THE GEORGIA UNIVERSITY PROFESSORS SUCCESSFUL IN EXPERIMENTS WITH ROENTGEN'S DISCOVERY. PROFESSOR PATTERSON TELLS OF THE EXPERIMENTS IN FOLLOWING UP THE DISCOVERY. It develops that the department of physics of the University of Georgia was the first institution in the South to make successful experiments with the newly-discovered x-ray light. On February 8th, four days before Professor McKissick, of Auburn College, claimed to have made his successful experiments, Professor Patterson, of the University of Georgia, made a number of successful x-ray exposures. The apparatus used in the experiments at the University are similar to that used by Professor Wright, of Yale College, in his many experiments. For the last week successful experiments have been made daily. Colonel Charbonnier and Professor Patterson have

ordered new apparatus to continue their investigations, even farther than the professors of the northern and foreign institutions. 'Everything appearing in the newspapers which would throw light upon the subject and upon the experiments conducted elsewhere was carefully cut out and kept in a special portfolio.[1] On February 8th, the first photographs were taken by the new process. These were unsuccessful, the time of exposure being too short. Further researches have been made since with better results, and they have been published in full in an article in *The Engineering Annual* for 1896. The equipment of the University for working with Roentgen rays is very good. A fine Ritchie induction coil, giving a nine inch spark, is used in the experiments, and for the newly discovered electric prints we have a very excellent Toepler-Holtz static machine.' "

New York Tribune, February 27, 1896. "WITH A NEW TUBE. PROFESSOR McKAY OBTAINED AN ALMOST COMPLETE VACUUM. REFRACTED BY ICELAND SPAR. John S. McKay, professor of physics and higher mathematics at Packer Institute, has been conducting successful experiments with Roentgen rays. 'I think,' said the Professor yesterday, 'that the fact that the rays pass through quartz, and do not pass through rock salt and alum seems to indicate that the rays are of the ultra violet, rather than of the infra-red kind.' "

The Atlanta Constitution, March 2, 1896. "RAY EXPERIMENTS. SOME VERY SUCCESSFUL RESULTS AT THE STATE UNIVERSITY. PROFESSOR PATTERSON'S WORK. Athens, Georgia, March 1. (Special). During the last week many experiments have been made in different lines of the wonderful x-ray experiments. The apparatus of the department of physics of the University is the most complete of any institution in the South. 'We have a complete set of Crooke's and Geissler tubes. It (the tube used) is of German glass, as English glass seems to be useless. We have a tube here constructed of Uranium glass. The flourescence in it was brilliant, but it had no effect on a photographic plate. Unfortunately the physical department, like the others here, is much crowded for room, and we have no place suitable for mounting a steam engine. So that we have only a small gas engine to run the dynamos and it is insufficient to produce the required current, so we had to fall back upon our induction coil alone. It seems clear that Professor Roentgen's theory that the rays are ether waves with a longitudinal instead of transverse vibration, is gaining adherents and this is evidently because of the fact that on no other supposition can the peculiar behavior of the rays be explained. Boltzman thinks the x-rays are a fifth kind of ray, closely related to those of light, and are quite different from cathode rays. Dr. Lodge says that authorities in his country are hovering between ultra-violet waves on the one

[1]This portfolio is in a state of perfect preservation and is the writer's source of information for this article.

hand and longitudinal vibrations on the other, and think the latter hypothesis more correct."

New York Herald, March 10, 1896. "EDISON PICTURES A HUMAN HEAD. ONE OF HIS MEN (JOHN WREXFORD) SAT IN THE CATHODE RAYS FOR AN HOUR AND A HALF. DR. KIMBALL, OF AMHERST, SENDS THE RAYS BETWEEN THE JOINTS OF HIS CHILD'S HAND. Dr. Kimball will also try to get a radiograph of a human head."

New York Herald, March 11, 1896. "MAY MEDICATE RAYS. NIKOLA TESLA HINTS THAT STREAMS OF CHEMICALS MAY BE PROJECTED INTO THE BODY. WILL PRODUCE SLEEPINESS. BOMBARDMENT BY PARTICLES. In regard to the nature of x-rays, he says: 'I am getting more and more convinced that we have to deal with a stream of material particles, which strike the sensitive plate with great velocities. By exposing the head to a powerful radiation,' Mr. Tesla says, 'strange effects have been noted. For instance, I find that there is a tendency to sleep and the time seems to pass away quickly. Should these effects be verified by men with a keener sense of observation I shall still more firmly believe in the existence of material streams penetrating the skull.' "

New York Herald, March 14, 1896. "PRINCETON AND THE X-RAYS. PROFESSOR MAGIE'S LECTURE ON HIS EXPERIMENTS IN THE COLLEGE LABORATORY. ILLUSTRATED WITH VIEWS. LISTENED TO BY FORMER STUDENTS AND THEIR GUESTS AT THE HOTEL BRUNSWICK. The invited guests for the evening were Professor M. I. Pupin, of Columbia College; Lieutenant Henry Morrell, U.S.N.; Henry N. Tift, and the Rev. S. W. Pierson."

New York Herald, March 14, 1896. "WHAT ARE X-RAYS? NIKOLA TESLA BELIEVES THEM TO BE INAUDIBLE SOUND WAVES. SAYS HE HAS HEARD THEM. MAY BE PRODUCED WITHOUT CROOKE'S TUBES."

New York Herald, March 28, 1896. "FLUOROSCOPE IS A SUCCESS. EDISON HAPPY OVER THE PERFECTION OF HIS APPARATUS BY WHICH BONES IN THE BODY ARE MADE VISIBLE. SHOWED IT TO THE HERALD. THROUGH AN INCH AND A QUARTER PLANK THE REPORTER SAW HIS BONES CLEARLY. SHADOWGRAPHS BACK NUMBERS. WHAT IT TOOK HOURS TO LEARN LAST MONTH ACCOMPLISHED NOW IN THE FRACTION OF A SECOND. GREAT BOON TO SURGEONS. THE WIZARD WORKED FOR HUMANITY AND WILL NOT PATENT HIS WONDERFUL DISCOVERY."

The Electrical Engineer, February 26, 1896. *On the Present Hypotheses Concerning the Nature of Roentgen's Rays*, by Dr. Oliver Lodge, F. R. S. "Another fact that gives a gravitational look to Roentgen's rays is the fact that they appear to pay more attention to specific gravity or ordinary density than to any other property of matter."

The Electrical Engineer, February 19, 1896. "PROFESSOR SCHUSTER ON ROENTGEN RAYS. 'Roentgen's rays are not cathode rays—there can be no doubt on that point—but they are generated at the point of impact between the cathode ray and solid substance.'"

Phil. Mag., April 1896. "*X-Ray Focus Tubes*, by Wood. A form of horizontal focus tube in which the cathode is concave and is swung from the end of a rod at the middle of the tube, so that by rotating the tube the rays may be focused on different parts of it."

The Electrical World, February 29, 1896. "In a report in the columns of *The Philadelphia Ledger* on the discussion of a paper on Roentgen rays, read before the Franklin Institute, Professor M. B. Snyder is quoted as saying that his idea was that the Roentgen ray vibrations were transverse; he had no doubt about it."

The Electrical World, April 18, 1896. *The Source of the Roentgen Rays*, by Clarence L. Cory, J. N. LeConte, and R. W. Lohman, University of California. "Radiographs were taken which show that the source of the rays was the centre of the metal disc anode, the remainder of the anode, the cathodes and the fluorescent glass having no practical effect. Since the cathode rays from the fine wire cathodes impinged on the anode in the centre, and in a point, it seemed that the mere fact of cathode rays striking a solid made that solid a source of Roentgen rays."

The Electrical World, March 14, 1896. "*The Electrical World* has received the following interesting letter to be forwarded to Professor Roentgen. Professor Roentgen, My Dear Professor: I have been greatly interested in your discovery, and congratulate you on having jumped Edison's claim of being the only original Wizard (of the Nile). Your discovery is very interesting from a scientific point of view, but will you be kind enough to tell me if I can apply it so as to get an "X raise" out of my boss? As I am the humble recipient of the magnificent salary of $9.50 per week, even a V raise would be most acceptable, but I do not know how to apply the process to him. Shall I induce an 'electrical resistance' on the part of the office cat to having her tail squeezed in the letter press by the errand boy, then continue to cause a 'current' of envy in the entry clerk by flirting with the typewriter girl to prevent her from 'sparking?' I could give the bookkeeper a 'laden-jar' on the elbow while he is writing in the ledger, and cause a 'vacuum" by handing in my resignation. Would it work? I am afraid I might get an 'electrical discharge.' Please give me exact directions in your reply."

SELECTION OF LIQUID STATIONARY PHASES FOR THE SEPARATION OF VOLATILE MIXTURES BY GAS CHROMATOGRAPHY[1]

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Preliminary investigations on the nature of the volatile compounds involved in the flavor and characteristic aroma of peanuts produced during the roasting process showed the presence of water, aldehydes, ammonia, hydrogen sulfide, diacetyl and furfuryl derivatives. Since approximately 98 per cent of the gas produced during roasting has been found to be carbon dioxide (10), it is evident that whatever compounds are responsible for the aroma are present in very small quantities. The diversity of types of compounds present, as well as the minute quantities involved, led to the investigation of gas-liquid partition chromatography as a possible means of separation and qualitative identification of these compounds.

The elution-partition method of gas chromatography has been used to resolve a wide variety of materials in mixtures. The sample, mixed with inert carrier gas, flows through a partition column packed with inert support, such as celite, which has been coated with a relatively high boiling organic material. Since the components of the mixture vary in partition coefficient and time they are retained on the column materials, they will travel through the column at speeds characteristic for each component of the mixture. The volatility of the individual substance is not as important for separation as are the relative vapor pressures of two substances when dissolved in the stationary liquid. The selection of the proper high boiling liquid for the stationary phase is fundamental to any given separation. The choice of liquid depends on the composition of the sample and on the temperature at which the sample is to be run. Keulemans (9) has given an excellent discussion of the factors involved in the selection of a liquid stationary phase. Some of these factors are discussed briefly here.

There are two basic requirements for proper functioning of a stationary liquid: 1) it must produce a differential partitioning of the components to be separated; and 2) it must have sufficient capability of dissolving the components of the mixture so that it can hold them long enough for partitioning. If the liquid does not meet these requirements there is no separation.

Although the selection of stationary phase for the separation of a given mixture is largely empirical, there are some general rules which may be followed:

(1) If the mixture is made up of an homologous series of compounds a stationary liquid of a type similar to that of the components of

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the mixture will usually possess the best solvent power; e.g., if the mixture is made up of polar compounds, a polar liquid should be best. When any selective stationary phase is used, the compounds with the lowest solubility in it will have the lowest retention volumes and, in general, will be separated less efficiently.

(2) If the components of a mixture are dissimilar and a complete separation is desired, a stationary liquid which has no pronounced selective properties for any of the components might be chosen. This will give a separation roughly according to the boiling point and the efficiency of separation may be reasonably good for all components; e.g., a phthalate ester might be used for the separation of a mixture of hydrocarbons and oxygenated compounds. Where the mixture contains dissimilar compounds but only one type is of interest to the analyst, Rule 1 can be applied but it should be remembered that the presence of other compounds may alter the positions of the peaks. In the analysis of complex mixtures giving rise to many peaks, interference is particularly likely to occur. It is therefore the rule rather than the exception that such mixtures are run over two or more different stationary phases, or are separated into fractions and re-run over the same column.

(3) Certain solvents possess super-selective properties toward individual components of a mixture by the formation of adducts. This can cause a marked shift in the order of emergence. Butene-1 (b.p.-6.3°C.) and isobutene (b.p.-6.9°C.) can be separated in this manner by the use of a saturated solution of silver nitrate in glycol, which reacts with both butene-1 and isobutene, but forms a stronger bond with butene-1.

The amount of stationary liquid phase coating the inert support may vary from about 15 to 50 per cent by weight. Above 50 per cent the material becomes sticky and the particles are not separated from one another. When a large proportion of liquid is used, the separation may be impaired by diffusion phenomena in the solvent. At very low liquid levels the support may possess enough residual adsorptivity to cause tailing of the elution peaks. The percentage of stationary phase for best separation depends somewhat on the size of the sample used, since a high ratio of stationary phase to support gives better results with large samples, and a low ratio gives better results with small samples. Since the time necessary for establishment of equilibrium largely determines the rate of flow which can be used, low liquid ratios and small samples allow higher flow rates and the samples take considerably less time to run through the column.

The presence of water in a sample introduces complications since it is frequently adsorbed to a certain extent by the support and few stationary liquids are compatible with it. Glycerol, diglycerol and certain polyethylene glycols have been used with water samples with some success. When the proportion of water present is very large, however, even these types of stationary liquids are not satisfactory. This problem has been a serious one in the work on peanut

flavors since many of the aroma constituents are water soluble or steam distillable.

The use of many different stationary liquids for the separation of specific mixtures has been reported in the literature. Before a liquid can be used for a particular separation with any assurance, however, it is necessary to test it with the particular compounds for which it will be used.

Since we are interested in natural products and the volatile substances which might be present in them, four mixtures were prepared which were presumed to contain a representative cross section of these types of compounds. These were:

(1) An alcohol mixture containing 0.1 mole each of methanol, ethanol, propanol, isopropanol, and primary, secondary, and tertiary butanols.

(2) An aldehyde and ketone mixture containing 0.1 mole each of acetaldehyde, acetone, and butanone-2.

(3) A volatile organic mixture containing 0.1 mole each of methyl and propyl mercaptans, dimethyl sulfide, and dimethyl disulfide.

(4) An acid mixture containing 0.1 mole each of formic, acetic, propionic, and butyric acids.

The following materials were chosen for testing as liquid stationary phases, some because they were readily available, and others because they, or materials similar to them, had been reported in the literature as satisfactory for various separations: tributyl phosphate, tricresyl phosphate (7, 11), Hyvac oil, carbowax-1500 (3) (a polyethylene glycol), paraffin wax, dibutyl phthalate, dioctyl phthalate (6, 13), diethyl sebacate, triisobutylene (1), N, N-dimethyl formamide, squalane (5), glycerol, DC silicone 200 fluid, stearic acid (8), tributyl citrate, mono-butyrin, tri-butyrin, 1, 3-propanediol monolaurate, DC high vacuum silicone grease (2, 4), tetrahydrofurfuryl acetate, and didecyl phthalate (12).

Column materials were prepared in each case to give a 30 per cent weight/weight mixture of stationary liquid on the inert support. This was obtained by mixing 6 grams of each of the above materials, dissolved in a suitable solvent (ether, hexane, pentane or water) with 14 grams Celite 545. These mixtures were air dried at room temperature before packing into the columns. All columns were prepared using U-shaped ¼-inch outside diameter 4 foot stainless steel tubes. Helium was used as the carrier gas and the temperature of the column was maintained at 120°C. at all times.

Each of the four mixtures was run on each of the columns and the resulting curves were compared. Theoretically, the number of peaks obtained with each mixture should be the same as the number of components added, provided that all of them separated. In some cases, however, there were more peaks than components in the mixture. These extra peaks presumably are accounted for by impurities present in the original liquids as no attempt was made beforehand to purify the compounds used in the preparation of the mixtures, with the single exception of acetaldehyde. The columns which gave the largest numbers of well-separated, distinct peaks,

for any mixture were assumed to have the best separating efficiency for that mixture.

On the basis of the rules given above for the choice of a stationary liquid, one might have chosen stearic acid as the best stationary liquid for a separation of the acids and glycerol or Carbowax-1500, for separation of the alcohols. These two mixtures were made up of homologous series of compounds which should be fairly easy to separate. Stearic acid was found to give the best acid separation. The curve obtained is given in figure I where minutes retention

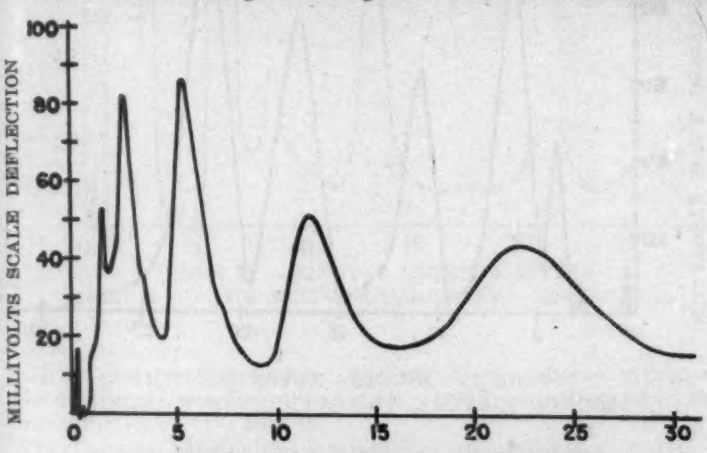

FIGURE I. MINUTES RETENTION TIME
ACID MIXTURE, STEARIC ACID COLUMN

time is plotted against millivolt readings. The separations obtained with tributyl citrate and tricresyl phosphate were almost as good as those obtained with stearic acid. The prediction did not hold for the alcohol mixture, however, where the best separation was obtained with tributyl citrate. The curve obtained is shown in figure II. Diethyl sebacate and tricresyl phosphate also gave fairly good separations of the alcohol mixture. None of the stationary phases tested was capable of separating the secondary or tertiary from the primary alcohols.

For separation of the aldehyde-ketone mixture the prediction should probably have been based on a non-selective stationary phase such as the silicones or paraffin, or for one of the esters or alcohols as being fairly similar in nature. The best separation was obtained on the tributyl phosphate column with tributyl citrate and tricresyl phosphate next. Figure III shows the curve obtained using tributyl phosphate.

The volatile organic sulfur mixture contained 3 dissimilar types of compounds so here again we would have predicted a non-selective

stationary phase, such as the silicones or paraffin, or a liquid with a wide range of selectivity, such as the phthalic esters. The Carbowax-1500 column gave the best separation. The curve obtained is shown in figure IV. Since this is a polyhydric alcohol this may be attributed

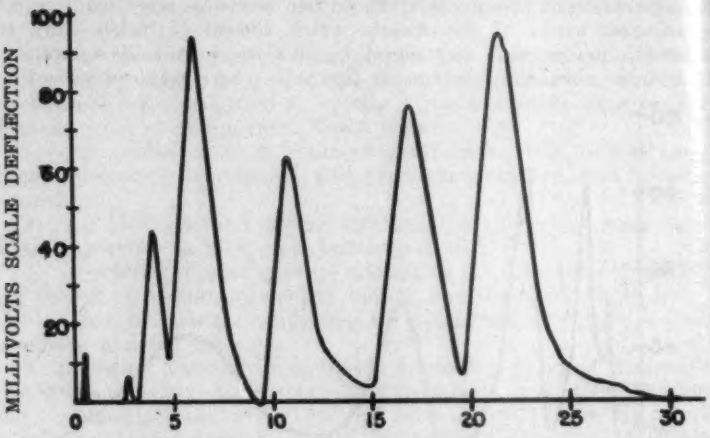

FIGURE II. MINUTES RETENTION TIME
ALCOHOL MIXTURE, TRIBUTYL CITRATE COLUMN

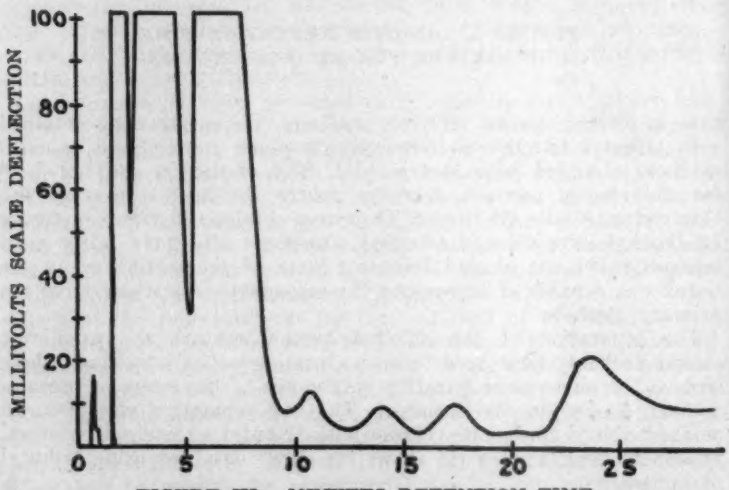

FIGURE III. MINUTES RETENTION TIME
ALDEHYDE-KETONE MIXTURE, TRIBUTYL PHOSPHATE COLUMN

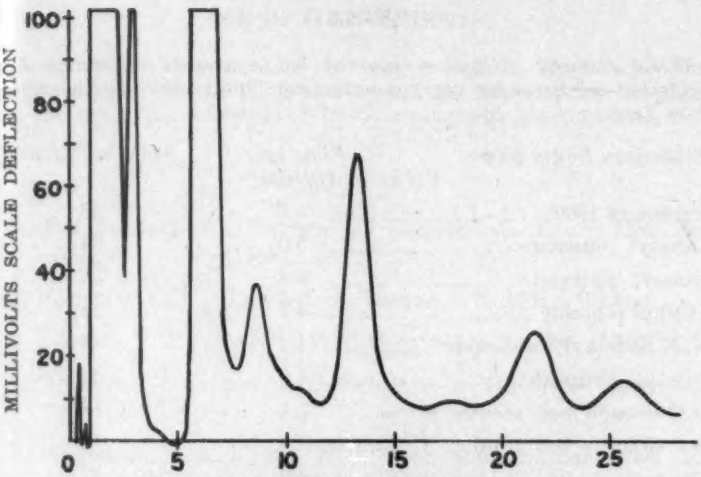

FIGURE IV. MINUTES RETENTION TIME
ORGANIC SULFUR MIXTURE, CARBOWAX - 1500 COLUMN

to hydrogen bonding between the sulfur and alcohol hydrogens. The predicted paraffin column gave a good separation here, also, as did the tri-butyrin column.

The poorest columns for separation of all mixtures proved to be the N, N-dimethyl formamide and triisobutylene columns. Neither gave any separation on any of the mixtures. Table 1 gives a tabulation of the total number of peaks obtained with each stationary phase on all four mixtures and gives the flow rate obtained with each column. A comparison of the flow rate with the separating efficiency showed that the difference between columns which gave good separation and those that gave poor separations was not related to differences in packing density of the various column materials. This was the only variable which could not be controlled. The tri-butyrin column, one of the best, had a flow rate of 4.3 cc/min., however, whereas that of the dimenthyl formamide, which was one of the poorest, was 4.2 cc/min. The flow rates varies from 3.9 to 7.8 and, although the two poorest columns did have the lowest flow rates, the highest flow rates did not occur on the columns which showed the greatest overall separation.

The stationary liquid phase which gave the best separation of all four mixtures was found to be tricresyl phosphate. Tributyl phosphate, tri-butyrin, tributyl citrate, and Carbowax-1500 were fairly good for separation of all the mixtures. This work afforded an idea of which stationary liquids might be useful to our problem of the separation of components involved in the aroma of peanuts.

TABLE 1

Total number of peaks obtained on separation curves of four different mixtures by various stationary liquid phases with various flow rates.

Stationary liquid phase	*Flow rate cc/min*	*Total no. of peaks*
Carbowax-1500	5.8	38
Dibutyl phthalate	5.0	34
Didecyl phthalate	5.8	36
Diethyl sebacate	4.8	36
N, N-dimethyl formamide	4.2	8
Dioctyl phthalate	4.6	36
D-C silicone high vacuum grease	5.5	18
D-C silicone 200 fluid	5.6	16
Glycerol	6.5	22
Hyvac oil	5.8	26
Mono-butyrin	5.8	40
Paraffin wax	6.0	32
1, 3-propanediol monolaurate	4.8	29
Squalane	7.8	23
Stearic acid	6.7	35
Tetrahydrofurfuryl acetate	4.6	28
Tributyl citrate	5.9	38
Tributyl phosphate	6.0	36
Tri-butyrin	4.3	38
Tricresyl phosphate	4.9	40
Triisobutylene	3.9	8

ACKNOWLEDGEMENTS

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SHELLS AND ASSOCIATED MEDICINES AMONG THE CUNA INDIANS OF SAN BLAS

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A number of years ago I had been given a Cuna tuikla winkwa or shell necklace. It consisted of a primary strand of commercial beads from which dangled at one-inch intervals five three-inch strings of the same. A money type cowry was suspended at the free end of each of these five short strings. The appearance of this necklace made me suspect that hidden away in the Cuna culture somewhere was the use of the cowry, an ancient female and Earthmother symbol to insure fertility, that has been worn by maidens the world over since prehistoric times. And because it represents the great womb of the eternal Earthmother from which all living things issue and to which they must return; as far back as early paleolithic times the cowry has been buried with the dead to insure that they would be born again of the great Earthmother. Often the dead were doubled up into the foetal position in order to further suggest the symbolism of rebirth.

I found that cowry shells or shells of small closely related gastropod molluscs such as the volute may be strung on strings separated by a dozen or so colored beads of commerce, or they may be arranged as described above for my necklace, which is almost identical with the fertility girdle worn in various parts of the world in the past and in Africa still today.

Most Cunas are reticent to talk about it, but several old Indians of Mulatuppu said that Cuna mothers make a necklace of cowries for each daughter when she is ten years old, and the child wears it off and on until her inna feast of marriageability. Otelia, a young lady of Mulatuppu, told me that at the time of the Inna Feast it is laid away in a box as a prized, personal possession. She showed me hers.

Olowitinappi mentioned that it may be taken out and worn during pregnancy to insure an easy delivery. Olowitinappi did not seem to be so certain of the general use of the tuikla winkwa among female children, but revealed that the cowry and shells in general had a very important role to play in obstetrics.

To describe this broader use of shells Olowitinappi brought me an interesting series of medicine pictures which represent an adjunct to *Mu ikar*, the childbirth chant that must be sung during pregnancy. The shell treatment is used to counteract the danger to pregnancy and especially to parturition occasioned by broken taboos of various sorts. A special chant accompanies the use of this medicine, as usual.

While Olowitinappi was describing the symbols, we had available a collection of shells belonging to Margaret Iglesias of the Mulatuppu Baptist Mission, and hence my informant could identify for me some of the specimens used in the medicine.

Figure 1 shows the nature of the shells in the formula. The first line of the manuscript (Fig. 2.) represents the medicines used on the pregnant woman if she has walked into the sea (as is necessary daily in answering the calls of nature) and by accident has stepped upon an octopus, which is highly taboo because it can make extremely difficult or stop childbirth completely.

The medicine man says that if you try to pull the animal out of a large morpep conch shell you will find that it makes itself so extremely hard and sticky that it is impossible to move it. By sympathetic magic this reluctant condition of the conch animal may be used against a similar reluctance on the part of the child and uterus at childbirth. Olowitinappi even justified his belief in this sort of sympathetic magic by saying that medical men in civilized countries today also use a great deal of such magic.

FIGURE 1. *Shells used as obstetrics medicine correspond to numbered list given in text. Backrow: no. 3 Morpep tummat, no. 4 morpep namakke. Middle row: no. 6 ti kolet, no. 7 ti kolet saluka, no. 8 tuikla tummat, no. 9 tuikla pippi. Front row: no. 19 salu kaya kinnit, no. 15 sammim tummat, no. 13 ti kammu.*

FIGURE 2. *Medicine pictures representing shells and associated obstetrics medicines. Descriptions given in text.*

For example, when they vaccinate against smallpox they are applying a countercharm to prevent the development of the disease. In a like fashion, Olowitinappi argues, the Cuna medicine man by scratching tiny particles off these shells into water which the patient must drink, immunizes that person against the development of the "difficult labor disease."

I asked if the pictorial resemblance of some of the prescribed shells (cowries especially) to the genitals of a human female did not suggest its use in pregnancy and parturition. Olowitinappi squirmed and said, "Not very much." He wanted to put the emphasis upon the hardness of the conch animal and its abundant slimy secretions which he thought to be a more important similarity. Possibly some of the ancient pictorial significance of the cowry as a womb has been lost among the Cunas because the symbolism has been widened to include so many kinds of shells, as happened in many other parts of the world.

That cowry-like shells once represented the Earthmother's genitals

among American Indians is evidenced by the Haida story of the Flood in which the sole surviving hero mated with a cockle shell to produce the postdiluvial races of mankind. In the version of the Muratos tribe the hero of the Flood cut off his phallos and stuck it into the earth to produce the human progeny, thus identifying the action of the hero in the Haida story as mating with the Earthmother.

Several Aztec statues of the Earthmother show her fertility girdle made of shells similar to those volutes upon some of the Cuna fertility necklaces. It is well known that ancient Earthmothers of Egypt such as Isis, of the Near East such as Astarte, and of Europe such as Hera, wore fertility girdles usually featuring the cowry.

With the onset of labor the Cuna midwives watch carefully the abdominal movements of the expectant mother, and one of them hastens to the home of the medicine man to advise him of a specific "disease" which the labor possesses. The medicine man, sitting among his myriads of medicinal stones, bark, roots, leaves and whatnot selects the proper medicine to counteract the disease devils whose activity is described, and he sings the appropriate medicine chant to accompany it. He intones this description of affairs to his two special medicine dolls, one male (made of katep walla wood) and the other female (made of surrup walla wood). He chants in the Tulalele special secret medicine language that the uchu dolls understand in which the patient is referred to as Walepunkwa. He tells the spirits of the various obstetrics medicines about the sickness. The spirits of the medicines view all that Walepunkwa is seeing in her dreams. Maybe she is looking at snakes, or she may be in a coma. The medicines and medicine dolls observe what is the condition in her dreams or state of mind which is predictive of the type of more severe disease that is about to come to her, and these medicines and the medicine dolls comprehend. The dolls are instructed to take away the bad dreams of Walepunkwa. They are warned to be on the lookout for the brutal and malevolent Mu Puklipe who has charge of the spirits of the monkeys and carnivores (possibly placental difficulties) which she may send to disrupt or interfere with the birth. The medicine man wets his dolls with water or with a medicine bath so that they may see more clearly the horrible Mu Puklipe and the animals that she has with her, whose evil influences she is going to use later against the pregnancy.

When labor pains start, this means that "there is a snake at the doorstep," presumably a poetic way of saying that sharp pain and danger are at the vulva. This snake at the door is called Kinkitinalilele in medicine language. Against him must be employed snake fang medicine as a counteractive, which Olowitinappi calls an antitoxin or vaccine. If hemorrhage takes place, cotton must be burnt and its ashes in water used to wash the patient's body. If cotton is not available or fails to stop the bleeding the medicine man employs ashes from the cooking fire. Olowitinappi says that when these are used they are caustic and the hemorrhage stops immediately.

If Walepunkwa is delirious and is grinding her teeth (tumpir) the medicine man sings the *Mu purwa ikar* (The Earthmother's Wind

Wa-). The grinding is really caused by two vines rubbing together in the jungle due to the wind. However, the name of the specific tumpir will be that of the Chief of the particular wind that happens to be blowing on the vines at the time, for example, "Sakirpurwa e Saikla" if it is the northwest wind. The tumpir is treated by the medicine man going to the jungle, finding the two offending vines, cutting rubbed bark from both vines and using it as a medicine.

Presumably, as among the Sumerians, Hebrews and others, the first appearance, attitudes, positions and actions of the unborn infant are prophetic for the life of that person, and the Cuna midwives are all experts in neonatomancy. Mesopotamian literature mentions children looking like Khumbaba and a serpent. If the newborn child is to be bitten by a snake during his lifetime one can start preventive treatments with the counter poison of na wood.

Olokukurtilisop, the Nan Tummati or Great Mother, was the first one to give birth, and hence she knows all the spirit forces that hinder and the medicines that control them.

Allegorically, at the lower right of our medicine pictures (Fig. 2.) sits Mu Puklipe (on an Earthmother's table) who orders her animals to destroy the mother and infant at childbirth. Just opposite (upper left) are the pictures of the medicine dolls which oppose her actions. Between the dolls and Mu Puklipe are depicted all the medicines.

The first row of figures in this manuscript (Fig. 2.) shows medicines against the disease of difficult labor caused by the spirit of the octopus upon which the Walepunkwa has stepped. "The flow of blood has become clogged as leaves may stop up a small river."

The second row shows medicine, against the disease caused during pregnancy by having touched, or having eaten a hermit crab. The birth canal is closed.

The third row shows medicines against having touched other taboo things. When the wekar nono medicine (monkey skull) is called upon to treat these diseases he, in turn, calls upon number 38 (?) and ipkuk nono (anteater skull). "They go after the disease, bang, bang, bang, like a chain reaction," says Olowitinappi.

The fourth row shows medicines against having eaten or killed taboo things, or Walepunkwa may have fed a monkey which is considered as a very bad thing to do during pregnancy.

The fifth row shows medicines against having had turtles in the house or having encountered a snake in the mountains. In this case ukkunaikpe nukar (rattlesnake teeth) may be administered. This medicine has the advantage of being able to assist other medicines.

The following is a list of medicines in the manuscript (Fig. 2.) together with their identifications:

1. Uchu ome (female doll).
2. Uchu macheret (male doll).
3. Morpep tummat (pink giant conch).
4. Morpep namakke (queen helmet shell).
5. Morper swikolet (conch).
6. Ti kolet (long shelled snail).

7. Ti kolet saluka.
8. Tuikla tummat (large spotted cowry).
9. Tuikla pippi (volute).
10. Salu (round, black snail).
11. Suk mur murruk (king crab).
12. Ti salu (fresh water snail).
13. Ti kamnu (common speckled toothless shell).
14. Sammim pippikwa (little, flat brown landsnail).
15. Sammim tummat (big, flat brown land snail).
16. 6 kolle weddi (ti kolle, river snail).
17. kolle (snail).
18. Salu nusa (razor clam ?).
19. Salu kaya kimmit (bleeding tooth shell, best when having yellow background and well marked designs in red and black).
20. Suk swili (crab).
21. Temar tulup (sea lobster).
22. Temar tulup ankia (smaller sea lobster).
23. Tiwar tulup (river lobster).
24. Suka (male blue coconut crab).
25. Suknan (female of above).
26. Ti naikpe (water snake).
27. Yarpi (eel).
28. Moli nono (cow's horn).
29. Saptur palit moli (tapir skull).
30. Sin nono (pig skull).
31. Yanna nono (peccary skull).
32. Taim nono (alligator skull).
33. Iskin nono (lizard skull).
34. Sule nono (monkey skull).
35. Usu nono (agouti skull).
36. Sulu nono (monkey skull).
37. (?)
38. Wekar nono (monkey skull).
39. Ipkuk nono (anteater skull).
40. Ukkunaikpe nukar (rattle snake tooth).
41. Naippe nipalit nukar (sky snake tooth).
42. Naikpe nukar (snake tooth).
43. Morro nono (sea turtle skull).
44. Yauk nono (sea turtle skull).
45. Tinku e mali (mountain turtle femur).
46. Yar morro e mali (mountain turtle femur).
47. Perro nono (sloth skull).

Number forty is followed by four medicine dolls that are watching Mu Puklipe.

The Great Original Earthmother and her assistant Earthmothers into which she finally has expanded in Cuna thought, are active in determining development, and still shed their beneficial influences during childbirth. The exception is Mu Puklipe. Olowitinappi said that Nan tummat (the Big Mother) whom he identified as Olokukurtilisop, used all the medicines listed above.

Olowitinappi named the Mus or Earthmothers as Mu sichit, Mu saptur, Mi sipu, Mu kollo, Mu Puklipe, Mu Wakalele, Mu maketir, and Mu matukwa. Since these good spirits overseeing and directing embryonic development have various titles it is not strange that some of the names fail to correspond to those in previously published lists.

FIGURE 3. *Medicine dolls thought to represent Cuna Earthmothers having fertility girdles.*

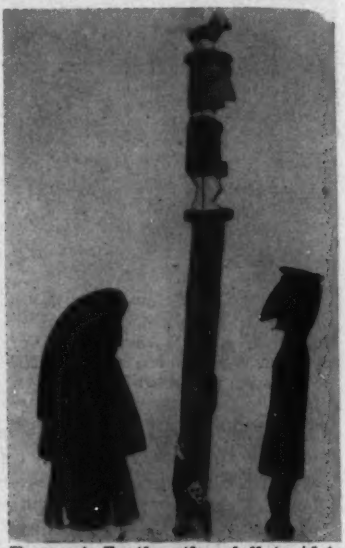

FIGURE 4. *Earthmother doll (said to be Olomakriai and also Olokukurtilisop), medicine staff, unidentified female dolls.*

These Earthmothers seldom are in evidence as uchus or medicine idols. I once asked the reason for their scarsity and was told by Olowitinappi that they "were too delicate to make," an explanation upon which he did not care to elaborate. Nevertheless, Olowitinappi had several female uchus (Fig. 3.) that I suspected of representing Earthmothers. One holds a girdle in front of her which was said to have been put there so that the children would not notice her semi-nude condition and gaze at things they should not think about. However, mesopotamian Earthmothers sometimes bound on the girdles. The other doll had a girdle that broke off.

Years ago I had bought at Ustuppo an uchu (Fig. 4.) which I had

been told was "only a child's doll." After hearing that there were a few Earthmother uchus in use I thought it probable that my former purchase was really the Earthmother, Olokukurtilisop, because she blended into a four-legged chair which I took to be the sacred Earthmother's table representing her genitals. Such a table-throne was used by Ishtar and also by Aryan An. I showed a drawing of this doll to Olowitinappi who promptly said it was Olomakriai, an Earthmother. Olopaite the Kantule or High Priest of Mulatuppu also has some Earthmother uchus, and he identified my doll as Olokukurtilisop.

FIGURE 5. *Earthmother dolls. Left to right. Olomakriai, Olokukurtilisop, Olokukillikinya.*

I photographed several of the Earthmother uchus belonging to Olopaite (Fig. 5.). The one to the left is Olomakriai. The one in the middle with separate feet is Olokukurtili (Olokukurtilisop). The daringly nude one to the right with small head and large pelvis is Olokukillikinya.

In Ailigandi I chanced upon a large spotted cowry that had been used as obstetrics medicine. The outside layer had been scratched off exhibiting longitudinal striations pictorially resembling muscle fibers. I showed it to Manipaite, an obstetrician of Ailigandi, who pointed out that the fine lines in the under layer of shell on the back of the cowry and said when labor stopped it was because "these lines are too close together," apparently meaning that the muscle fibers of the vagina have failed to expand. The man from whom I bought the large cowry spoke of the smaller variety as sin orka (pig bone) which seems to have a phallic meaning. The large species he called Mu sin orka that probably refers to its association with the Earthmothers of reproduction.

Olowitinappi said that if labor stops and none of these many medicines succeed, he selects a pair of round, white clam shells. "You see, when you insert your fingernails between these shells on the living animal and pull, it is absolutely impossible to get the shells apart. These clam shells are therefore a most powerful medicine for opening the tightly closed womb, and I use them as a last resort. Then the womb opens up."

SUMMARY

Among the Cuna Indians the necklace of small cowries is used to produce sexual maturity and fertility in girls, and it may also be employed later by its owner to assure a normal pregnancy and parturition. The medicine man may consider the large, spotted cowry as an anatomical representation of the woman's uterus even to the "muscle fibers" under the outer layer of shell. These lines become a countercharm against failure of the vaginal muscles to relax. Among the Cunas the use of the large, spotted cowry as medicine at parturition is extended to include many kinds of molluscs and crustaceans administered in conjunction with mammal skulls of various sorts and even rattlesnake fangs.

MONTEZUMA'S SACRED MEDICINE CANE RETURNS

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Ignacio Montezuma,* aged Chief of the Guaymi Indians of Western Panama, mounted once more upon his sturdy little pony. He came down slowly from his mountain home using the eight hour trail leading to Remedios, a frontier town in the relatively wild and unsettled Province of Chiriqui. Because of his feeble condition the chief made his trip in two days, resting a number of times. He spent a night at the halfway point.

The purpose of his arduous journey was to honor a white man, a great friend and world famous student of Indian cultures. That man was Alpheus Hyatt Verrill of Chiefland, Florida, who for thirty years was welcomed by tribe after tribe from Alaska to Tierra del Fuego.

Mr. Verrill was a most highly gifted person, an authority in many fields who painted oil portraits and collected anthropological specimens for the great Museum of the Indian Heye Foundation, in New York City. His knowledge was encyclopedic. Between expeditions and after retirement from field exploration he managed to write and publish one hundred and fifteen books, several of them dealing with Indians.

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*When the Guaymis were first visited by an anthropologist it was learned that their Supreme Chief is always called Montezuma, and that the chieftianship is hereditary in one of the large families of the tribe. Montezuma is not a Guaymi word but an Aztec title in the Nahautl language referring to physical prowess. In its complete form of Motecuzomailhuicamina it means, **"The chieftian who when infuriated shoots arrows beyond the horizon."** The Guaymis have the Aztec atlatl or spear throwing stick and a number of other objects, symbols and practices suggesting Aztec influence. These facts have led to the theory that Western Panama was conquested by a late Emperor of the Montezuma dynasty in Mexico, one of whose relatives established the Montezuma dynasty of the Guaymis in Chiriqui.

Many years ago Mr. Verrill, on horseback, ascended the precarious mountain trail to live a month with the Guaymis. In one of his books he described that trip.

"Three days of fearful trails—traversing razor-edged ridges with yawning abysses on either side, skirting terrific precipices where a misstep meant certain death, fording torrents, scrambling up one precipitous mountain side and sliding down another—brought us at last, tired, aching and sunbaked to the meeting place. A marvellously beautiful spot it was! In the midst of a maze of cloud-draped ranges a great flat-topped, isolated mountain rose like a stupendous pyramid. Upon this in the center of the level place at the summit, stood the ceremonial house or temple, an immense structure of fresh thatch and timber. . . ."

Mr. Verrill won the friendship of the Guaymis. From them he received not only the honor of being a blood brother, but also a medicine chief of the tribe in a solemn ceremony within their thatch-roofed, cane-sided Temple to the Sun that graced a high mountain peak. At that time Mr. Verrill was given a Guaymi medicine cane on which were carved a number of religious symbols.

The recipient of the cane had found a medicine man at the point of death and by means of first aid measures had restored him. For this miracle he was presented his Guaymi medical degree and the sacred symbol of his office, the medicine cane, with its sacred name that cannot be revealed to the uninitiated. But the medicine cane is actually much more than a physician's diploma. It is an international passport, respected and honored by all Indians who know its meaning. It entitles the bearer to professional courtesies, guest privileges and safe conduct among all the tribes through which he may care to journey.

Chief Khalserten Sepass of the Canadian Okanagans once stated that every four years his tribe had played host to the great Sun Ceremony at which occasion they entertained representatives of Sunworshipping tribes from as far away as Yucatan. It might require as much as six months to get there but the trip could be accomplished easily by a medicine man with his international passport cane.

Mr. Verrill was given the cane after a most interesting ceremony in a local Temple of the Sun about which he wrote:

"The next instant the dance-chief came hopping from his corner carrying a basket and a bag. Thrusting his claw-like hand into the latter, he drew out a bead collar and a gorget, which he quickly placed about my neck. Next came a string of jaguar teeth and a filet of scalplocks. A painted drum was hung over my shoulders, and then, as Montezuma deftly drew the tribal mark of the Guaymis across my cheeks, and added two round spots (sign of medicine-chief) below them and a line down my nose, the dance-chief placed a crown of hair from the quaint ant-bear (sign of medicine-chief) upon my head . . . Neonandi (second chief), Montezuma and the dance-chief saluted me in Guaymi fashion, addressed me as "brother," and made short speeches."

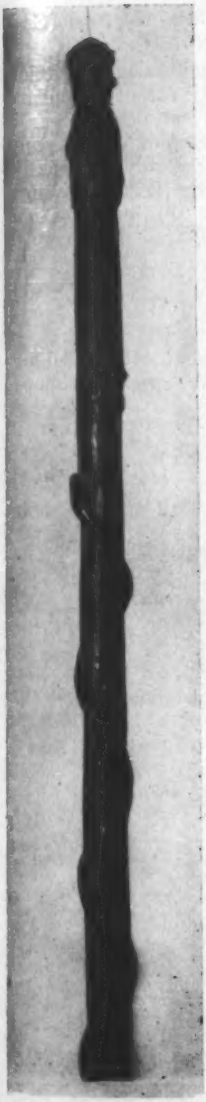

FIGURE 1. *The sacred medicine-cane presented to Alpheus H. Verrill by the Guaymi Indians.*

The symbols on the Guaymi cane are similar to those on the canes of many other tribes. At the top is the effigy of a medicine man who stands upon the staff that represents the Tree of Life (umbilical cord and foetal membranes of the Earthmother when she bore her children: plants, animals, and man). About the head of the medicine man is presumably the Circle of the Sun (shown at his feet on the canes of some tribes), representing the path of that greatest of gods through the signs of the zodiac or heavenly mansions along the ecliptic during one year. On the Tree of Life of the Guaymi cane is the Sacred Frog Obstetrician to the Earthmother, and about the Tree of Life is spiralled the Great, Phallic Serpent of the Sungod's creative power. This serpent (called panna nusu by Cunas) is encised with crossmark decorations and is painted black.

It is possible that the medicine staff of Aesculapius the Father of Medicine anciently had the same meanings because on the Aztec cane and others the symbols were reduced to a serpent entwined about a rod surmounted by an eagle. Some have even suggested that Moses was employing the same world-wide symbols of the ancient medicine men of Sunworship when he lifted up the brass serpent of healing in the wilderness, and it will be recalled that the magic of a number of such medicine staffs of Egyptian magicians were tested before Pharaoh. That of Moses caused blood, hail, lightning, locusts and water, whereas that of Aaron became a cannibalistic serpent, grew almonds and induced the production of frogs and lice. Hebrew tradition says that Moses cut Aaron's staff from the Tree of Knowledge. A Cuna medicine man while treating a disease stands his medicine staff upright in the sand of the hut floor facing the sick one so that it may shed its life-giving magic upon the patient. The brass serpent of Moses on a pole (really the serpent-god Nehushtan) was still being worshipped 727 years later in Solomon's temple at Jerusalem until King Hezekiah destroyed it.

Elisha ordered his servant Gahazi to heal a child by laying his (Elisha's) staff upon the child's face, but this Gahazi failed to do.

Most authorities agree that Asklepios was the

son of Apollo (the Sungod) and that his mother was Koronus (Sea-Gull) the daughter of Thessalian Phlegyas.

He was left by his mother to die on the mountaintop Titthion (the nipple). The dog of Aresthanas, the Goatherd, found the infant and continued to guard him. When Aresthanas set out in search of his missing dog he discovered the infant Asklepios in company with the goat that nursed him, the Great Snake (possibly the phallic representation of Apollo the Sungod) and the dog. As Aresthanas, the Goatherd "drew near he saw a bright light shining from the child. So he turned away. 'For surely,' thought he, 'the hand of God is in this place,' as indeed it was. And soon the fame of the child went abroad over every land and sea, how that he had power to heal the sick and that he had raised the dead." This suggests the later miracle stories in the book of the Infancy of Jesus.

Usually Asklepios' wife is given as Lampetie, daughter of Helios (the Sungod). Machaon and Podaleinius are his sons, both herophysicians named as heroes in the siege of Troy.

The most famous shrines in the worship of Asklepios as God of Healing were located at Epidauros in Laconia and at Cos. The shrine at Epidauros was built where a Great Snake (phallic symbol) had disappeared into the Earth. This may be a cryptic way of saying "over the Earthmother's vagina," just as the Navajo kiva is located beneath the earth's surface and the Pottowatomi Me-di Medicine lodge is located between the four Trees of Life representing the just shed umbilical cord of the Earthmother. We have shown elsewhere already that this is the normal position for above-ground temples.

In the rite of Asklepios the sick slept in his holy precincts at Argive Epidauros, Athens and Cos where they were healed by the presence of snakes. All except the dying and women in childbirth were admitted.

At the height of the popularity of Asklepios there were some two hundred temples dedicated to him where patients spent a night of "incubation" in the Temple of Healing or in the surrounding grove. During this time the individual diagnosis was revealed to the physician-priests in dreams (the normal vehicle of divine revelation).

This reminds one of the method by which the neles of the Cuna Indians arrive at their diagnoses. A medicine man stands his medicine cane in the sand floor facing the patient. He places his best idol under the hammock of the patient and the idol learns what is wrong. But since the spiritual eyes of the physician are not open like those of the nele, it cannot communicate well with him. The medicine man takes his idol, which now knows the symptoms, to the nele. The nele or seer is clairvoyant and en rapport with idols and spirits of the underworld. The nele places the medicine man's idol beside his kindred "spirit idol" under his hammock for a night. (Night is naturally the best time for the activity of spirits). The two idols talk over the case, and possibly they take other spirits into their confidence. Then the kindred spirit idol reveals the diag-

nosis to his master in a dream. The nele communicates the dream diagnosis to the medicine man. This was probably the method by which the Witch of Endor conversed with the Ghost of Samuel.

In one legend Asklepios was taught medicine by Cherion, greatest of the centaurs. Asklepios heals with the blood of Medusa the original and principal Gorgon, who was originally the placental monster of the Earthmother, born as a protector (the ka of Egypt) to her two hero sons, Castor and Pollux.

FIGURE 2. *The aged Guaymi chief Ignacio Montezuma. Note the sacred quetzal feather and the famous Guaymi beaded collar.*

Athena supplied Asklepios with the Gorgon's blood, that from the veins of the left side producing death, that from the veins of the right side bringing patients back to life.

In the cult of Asklepios a magic staff with a serpent spiralled about it had great healing power. It could also rejuvenate men. It will be recalled that the Plant of Life in the Aetana was named "The-old-man-becomes-young-again."

Eshmun the Healer was a god of Tyre and Sidon whose popularity probably extended through Canaan and Philistia. He also had a magic medicine staff with a serpent coiled about it.

All of the snake-staff healing gods may inherit from Ningishzida the healing god of Sumeria, Babylonia and the Western Semetic lands, and he may inherit from still older snake-healers. Ningishzida is the Companion of Tammuz, the dying Sun-god, which possibly makes him correspond to Puksu the Morning Star god of the Cunas who was also a healer. The Babylonians said that when a child was born with a head like a serpent (frog-baby) it had been sent by Ningishzida. It might be added parenthetically that the mother of Tammuz bore the title of Ama-usugalanna meaning Mother-Great Serpent of Heaven who emanates from the Heavengod Anu.

The Sumerian Corn-goddess, Nidaba, has serpents springing from her shoulders as do the present-day Naga-kings of India.

In Africa the magic staff of the hyenas (similar to witches) is called Kirasa. It has the power of recalling the dead to life.

The pantribal medicine cult of the Snake of Africa reminds one of the pantribal nature of the medicine cult of the American Indians in having the snake medicine cane and other symbols in common. Eloise Street tells me that the Chilliwak, Thompson, Squamish, Okanagan, and possible the Kootenays had this traveling medicine cane. Among the Pottowatomies the cane consists of a serpentine vine spiralled about the main stem of a sapling, and curiously enough, this cane is referred to as "the Staff of Life." Chief Shup-She has a ceremonial coup-stick the handle of which bears these same symbols and is called the Tree of our Great Mother's Vulva (Muttusk).

The Giantess Grid (mother of Vidarr, possible the Earthmother) had a famous, magic staff which she lent to Thor. Loki and Thor spent a night with the giantess during which she informed Thor about the magic and power of his enemy, Geirrod (possibly the Dragon). Then she lent him the girdle of might, the iron gloves and the magic staff. With this staff Thor and Loki crossed the mightiest of rivers, the Vimur. (Vimur may be the River of Life).

When in mid-stream Geirrod's daughter, Gjalp, caused the stream to rise, but Thor, finding out how she did this, hurled a great stone at her and chased her away. Catching hold of a rowan-tree, Thor pulled himself out of the river, and hence the rowan is called "Thor's Deliverance." At the palace of Geirrod the giant's daughters, Gjalp and Greip, are killed. Finally the giant himself is dispatched by a white hot bolt of iron that Thor sped through an iron pillar, through Geirrod and into the earth.

When Mr. Verrill was given his sacred Guaymi cane he was told that when he died it must be returned by a friend to the Temple of the Sun, together with a message about his passing. After this, decades passed and the incident was almost forgotten.

I had written to Mr. Verrill several years ago concerning my anthropological researches—a number of months before he died—and he had assisted me with advice and facts from his immense storehouse of knowledge. In addition, after his passing, his wife, herself having much Indian blood and many Indian friends, has continued to help me with an unfailing supply of judiciously chosen and meticulously copied references to the rare books of Mr. Verrill's magnificent private library and other sources. Thus, it was only natural when Mrs. Verrill heard that I was making my seventh expedition to the Cuna Indians of San Blas, Panama, that she would ask a favor to the memory of Mr. Verrill and to herself that I return the sacred Guaymi cane to Chief Montezuma at the Temple of the Sun. Of course, I was thrilled. I was proud to represent Mr. Verrill and to carry to its permanent resting place the sacred cane of so famous an anthropologist.

FIGURE 3. *A Guaymi Madonna in the delegation. The chief's nephew is seen in the background.*

But time pressed upon me, as it often does upon a college professor at the end of a busy term, and I found myself so occupied with exams and grade reports, that the matter of procuring the cane was neglected. Besides, I had been unable by correspondence to locate my Guaymi contact through whose kindness I was to enter the tribe. In fact, for that reason at the last minute I abandoned entirely the idea of visiting the Guaymis. However, upon arriving in Panama without the cane I found my Guaymi contact, Mrs. Fulleton, who said: "But you must have that sacred cane! It would be an insult not to return it to the Temple of the Sun." So I dispatched an airmail letter asking that the cane be forwarded at once.

Several weeks later I traveled west from the Canal Zone one hundred and fifty miles by express truck in the Province of Chiriqui over a very rough road, through a frontier that resembles the North American Wild West. The trip required eighteen hours because the driver pulled to the side of the road and slept for six hours. Cattle having Brahma blood graze the high plateau and hills. In huge

American cattle trucks they bounce over the rocks to distant markets in Panama City and Colon.

The little towns along the roadway are inhabited mainly by people of mixed blood: Indians, descendants of African slaves and whites who have fled from civilization. All of the variations of the three major races of mankind and their combinations stand out among them, and as I studied the anthropological types I thought to myself: "Holywood scouts should visit this place." Every possible variation in human face and form is present here, as vividly carved as the characters in a novel by Dickens. Even the dogs in the settlement streets reflect hybridization. Instead of the thin, short-haired, yellow, Indian hunting dogs with flare ears, one sees mongrels with symptoms of poodle, collie, dachshund, fox terrier, hound and other breeds, descended from the animals that immigrants brought with them.

I stopped at Remedios, a typical frontier settlement of some five hundred inhabitants with its half dozen general stores several of which are run by first generation Chinese-Guaymi crosses. Remedios also boasts a liquor store, three livery stables for ponies, and several cantinas. Nobody speaks about the Mayflower, family pedigrees or under what conditions their parents met. Here a man's worth is based entirely upon his own character and accomplishments, and there are not enough "white" men to create the problem of segregation.

From my unlighted room over the town's Indian style Restaurant I could hear all the arguments and conviviality of the customers: cattle truckers stopping at the Esso sign for gas, encomienda cars crowded with passengers to and from the "Interior" who, because of the rugged road and their close confinement needed to stretch their legs and grab a plate of aroz con carne, silent Indians who wandered down the mountains on ponies just because they wanted to get drunk and enjoy the process of racial degeneration that such a frontier town affords.

As luck would have it I met and talked to the chief's son, Antonio, on the first day. I gave him a pipe for his father, Ignacio Montezuma, though after catching the aroma of his breath I was not certain that either the pipe or my message would ever be delivered. I said I wanted to come up the mountain to the temple, but everybody, including the Indians, protested that only an Indian could make it at that time. So I waited.

This gave me a chance to examine Remedios and its environs. It provided me with an opportunity to explore the little Catholic Mission Church with its ancient altar and its clear-toned bell cast in pirate days. Because the tower ladder was too termite riddled to bear my weight but was safe enough for a boy, I sent one aloft to copy the inscription on the bell which read: "O LVCAS DES MELENS, 1682."

Lazaro Serran, the alcalde of Remedios, was historically minded and felt that the event of returning the sacred medicine staff was so important in the annals of his town that it should be returned to

Montezuma and his royalty in a ceremony to be witnessed by all the local school children. However, the dark-skinned, kinky-haired teacher at the Telegraph School prepared twenty-two typewritten questions for me to answer in front of his class, some of them so pointed that I suspected him of trying to discredit me before the alcalde. In private he kept discouraging me by saying: "Montezuma will never come down to receive that *cane*!" I, too, had some misgivings because I had never seen a Guaymi medicine cane before. When I opened the package from Mrs. Verrill I thought that she must have made a mistake and must have sent a Cuna medicine cane instead, because the one she sent was almost identical with the one given me by the Cunas. What if Montezuma should arrive, receive the wrong cane, declare my mission a fraud and brand me as an imposter? I was a bit afraid of that possibility.

On the third day an Indian rode to town and said that when he left the mountains Montezuma was planning to meet me in Remedios. At least, the return of the cane meant something to *him!*

Early on the fourth day I was walking along the highway examining granite, jaspar and fossilized clam shells. I was intrigued by a hypersensitive sensitive plant at the side of the road, which, after I snapped the terminal leaflets with my finger, closed all its leaflets as far back as one foot along the stem by the time that I could count "one." Just then two Indians passed me on their ponies. The one in the lead had his face painted with horizontal stripes and a row of dots in black and red, boasted a sheaf of sacred, green quetzal feathers on his hat and wore a strip of red cloth about the hatband of his native-woven headgear.

As I suspected, he was Montezuma's messenger who had come to tell the alcalde that Montezuma had slept last night at the halfway point, would proceed today to near Remedios, and after resting again, would meet him in his office at four o'clock.

Later I observed these two Indians examining carefully every article of merchandise on display at one of the Chinese-Guaymi tiendas. Finally, the painted nuncio stalked out of the store, swung up to his saddle in true Western style and clipped his pony's flank sharply with his short, improvised riding whip in a rapid series of vigorous strokes. The noble beast snorted, reared like a bucking bronco, turned sharply on its hind feet and took off at breakneck speed in a demonstration that would have thrilled the fans of Roy Rogers.

Punctually at four Montezuma and his entourage slowly rode into town and tied their ponies at the alcaldia where they were informed about the ceremony, while the school teachers of the town tried almost in vain to herd their unresponsive and uninspired pupils to form a hollow square on the spacious churchyard of Remedios.

A number of the Indian women wore three horizontal stripes of red paint on their cheeks. Several of the men also exhibited face decorations in red and black. Of these designs those of the High Priest were most ornate. What I took to be a row of black triangles of the Sungod were arranged above a red horizontal strip of the

Earthmother. In addition, there were many short, black vertical stripes in pairs that may have represented complementary male and female symbols. I noted that several Indians including Antonio's wife, had each of their upper incisors symmetrically clipped and filed to a point that produced a zig-zag smile, a custom of high significance to Sunworshippers in various parts of the world.

The old chief was emaciated, gray haired and all but edentulous. About his neck lay the famous broad, bright-hued beaded collar of the Guaymis and from his shoulders hung a colorful, native chakra bag. On his head he wore a Panama hat of Guaymi handicraft surmounted with sacred, green, quetzal feathers as befits an earthly proxy of the ancient Sungod.

FIGURE 4. *The Guaymi High Priest of the Sun.*

I presented my box of gifts consisting of two new, white shirts, a horn handled pocket knife shining with nickel plate, fifteen beautiful and costly strands of colored beads provided by my college students, together with many and varied new toys for the children. When Montezuma and his wife opened the package they were embarrassed because the gifts were so grand, so numerous, and so unexpected. Montezuma's wife rose to the occasion as best she could, presenting me with several chakra bags which she had made to sell, and on three occasions during the afternoon and evening the old chief apologized to me that if he had only known of my coming in advance he could have prepared a worthy present.

Then I unfolded the letter from Mrs. Verrill addressed to Montezuma and explained the accompanying photographs of its writer and her husband. Luciano Gonzales, a youthful citizen of Remedios, read a Spanish translation of that letter which he had prepared.

"To the gracious, honored Chieftian Montezuma, Greetings:

"Your brother medicine chief, Cuviboranandi, has gone over the hills to the west - - . He cannot bring to you the sacred cane, symbolical of his office in your tribe - - .

"May the sacred, symbolical cane come to rest in some shrine or temple of your tribe, to forever remind you, your people, and the sons and daughters yet to be, that Chief Cuviboranandi loved and respected your people and was proud of having been accepted into your tribe as an adopted brother - - .

"May the Great Spirit smile upon you and your people and bring everlasting peace to your heart.

"With much respect I sign this letter.

Ruth Verrill."

When I gave Montezuma the sacred medicine cane he took it in his unsteady hands, slowly turning it around and around again while scrutinizing it with his dim eyes and feeling out the carvings with an arthritic index finger. In reverence he bowed his head. He was silent and very thoughtful as though he was trying to recall something from the far distant past.

Finally, he said: "I did not give this cane!"

My heart sank. "Had Mrs. Verrill actually made a mistake? Would Montezuma denounce me as an imposter? What might the teacher of the Telegraph School say now? Would the alcalde think I had betrayed him?"

At length Ignacio Montezuma raised his head and looked into my eyes. A smile of conviction spread over his wrinkled, old face.

"I did not give this cane," he repeated firmly, and then continued, "It was my father who gave this cane, and he has been dead for more than forty years."

CALENDAR OF EVENTS FOR 1958-59

October 15.	Meeting of Section Chairmen and Councilors to plan program for Annual Meeting. 7:30 P.M., Wilby Room, Price Gilbert Library, Georgia Institute of Technology.
October 22.	Fall Meeting of Council. 7:30 P.M., Wilby Room, Price Gilbert Library, Georgia Institute of Technology.
January 5.	Section Chairmen issue call to their members for papers to be presented at Annual Meeting.
January 21.	Winter Meeting of Council. 7:30 P.M., Wilby Room, Price Gilbert Library, Georgia Institute of Technology.
March 1.	DEADLINE for submission of Titles and Abstracts of papers for the Annual Meeting, and for submission of *vitae* of persons to be nominated as Fellows in the Academy.
April 14.	DEADLINE for receipt of ballots at the office of the Secretary.
April 15.	Spring Meeting of the Council. 7:30 P.M., Wilby Room, Price Gilbert Library, Georgia Institute of Technology.
April 16-18.	Georgia Junior Academy of Science and State Science Fair. University of Georgia, Athens.
April 24-25.	Annual Meeting of the Academy, Mercer University, Macon